MASSACHUSETTS
AGRICULTURAL EXPERIMENT STATION, Amherst

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Annual Report

For the Fiscal Year Ending November 30, 1937

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

MASSACHUSETTS STATE COLLEGE
AMHERST, MASS.

MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

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ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION -- 1937

INTRODUCTION

F. J. Sievers, Director

The general policy of the Experiment Station Administration is so closely related to and guided by definite research projects that whatever changes occur from year to year are so gradual that they attract very little attention and cause no particular stir. This is as it should be in an organization where there is adequate vision and a sound foundation. Changes which come in the form of sound and gradual growth are generally indicative of a healthy organism. It is the belief that we are undergoing such changes.

One of these, and a very significant one, is evidenced by the increased recognition given to the economic factors that play so prominent a part in the interpretation and utilization of results from scientific investigations. The individual investigator has become gradually more conscious of the desirability and obligation for carrying his studies beyond the so-called factual and into the applied stage. He is developing greater courage in expressing himself in the interpretation of his results and this is sure to prove of great value in a field where unbiased opinions are not readily available from any other source. This development in the Experiment Station is becoming gradually recognized and is being appreciated and encouraged by those whom it attempts to serve.

The work in nutrition, as related to both human and animal well-being, has been hindered since its inception because of inadequate facilities pending the completion of construction in the nutrition laboratory. Last year's appropriation, however, made financial provision to put the entire laboratory into usable condition and this unit will soon be equipped to make a very desirable contribution to the research and general educational program of the entire college. These facilities and the qualified personnel available are being recognized by personal and industrial interests and, as a result, the demands for special research to serve specific problems are increasing.

The investigations under the Mrs. Henry Lang Fund have been encouraged by another gift of $5,000 from the same donor through whose generosity the fund was originally established and designated. There are evidences that this support is beginning to produce results that may aid in providing a more intelligent approach in dealing with those so-called deficiency ailments now so commonly recognized in human nutrition.

Among the poultrymen there is continued interest in the expansion of our facilities so that some of the nutrition problems now confronting that industry may be given research attention. A special item in the present budget, when approved, will provide this service, which should then be organized as a supplement to the present Feed Control program.

Because of opportunities for expansion through enlarged Bankhead-Jones support, it is intended to recognize the need for certain studies in weed control and fruit storage at the Cranberry Field Station. The urgency of this need is best evidenced by the fact that the cranberry growers themselves, through special funds provided through the treasury of the Cape Cod Cranberry Growers'

Association, have attempted to support the preliminary investigations inaugurated in this field. An additional staff member should be provided for that purpose.

The rapid development of interest in enlarged recreational facilities in New England, and especially in Massachusetts, has confronted us with many requests for information regarding the improvement of golf courses, lawns, roadsides, parks, etc. The Massachusetts Greenkeepers' Association has been most active and also most considerate in these demands. Realizing that the expansion of our service is possible only if adequate funds are available, this Association is determined to gain recognition either through an item in our budget or through special legislative action. If adequate financial provision is made available, the research in the Experiment Station can easily be expanded to deal with these problems.

The demands of the Arborists for more specific data regarding the culture of shade trees are gradually being met through certain services made available in conjunction with the activities under Dutch Elm Disease Control. Also, the enlarged facilities provided at the Waltham Field Station as a result of additional greenhouse and laboratory space for Nurseryculture which have just become available through new construction will serve in that connection.

The Regional Pasture Management Laboratory, established at Pennsylvania State College, which is now fully equipped and manned, is intended to supplement the research of the entire northeastern section of this country. It is sure to play a prominent part in promoting a better approach to the evaluation of the management phases involved in providing more satisfactory forage, a matter so essential to the success of the Massachusetts Dairy Industry.

Of the numerous cooperative investigations under way with several bureaus of the United States Department of Agriculture, the most recent, and in some respects the most interesting, is that dealing with soil erosion and its control. Most of New England, due to natural and economic factors, has developed a type of agriculture where pasture and grasslands play such a prominent part that the extreme erosion, quite common in other sections, is rarely in evidence. Nevertheless, the productivity of our soils is recognized as our most important natural resource and therefore deserving of our best consideration because the future prosperity of this country is very closely related to and dependent upon it.

In recent years cooperation in research has been given a great deal of encouragement. To the extent that it remains on a voluntary basis this is very desirable because it has a tendency to overcome some of the limitations of the high degree of specialization that has developed in agricultural research. When cooperation is promoted to the point where it takes on compulsory aspects it not only loses most of its value but may even become a handicap to sound progress. This is especially true when it reaches a stage where conclusions are based upon a compromise of opinions of the cooperative agencies rather than upon the actual research findings of individual investigators. Projects should not be undertaken on a cooperative basis unless it becomes evident, after careful analysis of all factors involved, that such an approach is desirable or even possible.

AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

A. H. Lindsey in Charge

A study of Pasture Improvement and Soil Management Practices in Massachusetts in Relation to Dairy Farm Organization. (C. R. Creek and D. C. Plastridge.) The results of this project were reported originally on a "type-of-farming area" basis to the cooperating agencies in Washington. In order to make the material more useful to the farmers of the State and to the Extension Service in the various counties, the data from the 113 farm records were retabulated and analyzed on a county basis. Copies of these reports were given to the farmers who cooperated in this project by supplying information on pasture treatment and farm organization. The results were also used by the extension specialists in county meetings on pasture management.

The years in which the seeded pastures were first treated ranged from 1920 to 1936, but the greater number of farmers began an intensive system of pasture treatment after 1929. The following table shows the number of farms and acres of each treatment for initial improvement of seeded pasture.

	Seeded		Fertilized		Limed	
County	Farms	Acres	Farms	Acres	Farms	Acres
Berkshire	22	354.3	21	346.3	12	154.8
Franklin	10	115.0	10	115.0	6	58.0
Hampshire	13	286.0	12	268.0	8	86.0
Hampden	14	80.8	12	72.8	10	69.5
Worcester	13	215.5	13	215.5	9	93.5
Essex	5	44.5	5	44.5	3	14.0
Middlesex	7	178.8	7	176.5	4	134.0
Norfolk	2	29.0	2	29.0	2	29.0
Bristol	3	29.1	3	21.7	3	23.4
Plymouth	4	34.5	4	34.5	2	17.5
Total	93	1367.5	89	1323.8	59	679.7

Prepared seeding mixtures for hayland and pasture, as well as miscellaneous mixtures of clovers and grasses, were used in the original improvement practices. In recent years, a greater acreage of Ladino clover has been seeded, especially in Berkshire county. Complete fertilizers, cyanamid, calnitro, and superphosphate were the chief materials used for the fertilizer treatments, with rates varying from 100 to 2000 pounds per acre. Ground limestone was the choice on the majority of farms, although hydrated lime was used in a few instances.

Fertilizers and lime were applied to established stands of hay and pasture grass on 57 farms as the initial pasture improvement practice. A total of 779 acres was fertilized and only 113 acres were limed in this type of treatment. The rate of application per acre varied widely for the different kinds of fertilizers used. Cyanamid, calnitro and high analysis complete fertilizers were seldom applied in excess of 500 pounds per acre.

The results of pasture treatment can be measured in the increased number of cow-days of grazing which are supplied per acre. Open untreated pasture on the farms surveyed furnished from 28 to 107 cow-days of grazing, while the seeded and treated pasture on these farms supplied from 142 to 289 cow-days per acre. Grazing on unseeded treated pasture ranged from 57 to 179 cow-days per acre.

Case studies were made on the effect of pasture improvement on the organiza-

tion of four dairy farms in the survey. These farms were in Plymouth, Worcester, Hampshire and Berkshire counties and in 1935-36 had milking herds ranging in number from 22 to 27 cows. A comparison was made of the pasture program and farm organization for the year before intensive pasture treatment and for the year 1935-36. The herds increased in size during this period by two, three, eight, and eleven cows. Milk was sold at retail on two farms and wholesale on the other two. Milk production per cow increased in 1935-36 over the former period on two farms and decreased on two. However, the total milk production was greater in the latter year on three farms. Adjustments in the dairy enterprise which were due partially to the pasture program also brought out changes in the organization of other enterprises on the farms.

The pasture program on Farm A consisted of alternating a small acreage of land between hay and pasture use and maintaining high yields with heavy applications of fertilizer and lime. Permanent fertilized pasture was supplemented by grazing from nurse crops and specially seeded annual pasture crops on Farm B. Seeded and treated permanent pasture was used on Farm C, but did not supply grazing for the entire season. Annual and rowen pasture are needed on this farm to supply adequate grazing. Farm D had a system of permanent seeded pasture which was grazed in small plots in rotation. Rowen pasture was used to supplement this treated pasture.

A Study of Adjustments in Dairy Farm Organization and Practices in Massachusetts. (C. R. Creek.) This project was undertaken in May 1937 in cooperation with the Bureau of Agricultural Economics of the United States Department of Agriculture to obtain basic data on farm organization, on physical and financial requirements for production, and on farmers' adjustments to various economic and technical changes. Another objective was to determine the relative profitableness of different farm organizations and of farming in the various dairy areas of the state.

Survey records of the farm business for the year May 1, 1936, to April 30, 1937, were taken on 263 farms in eleven counties during the summer of 1937. These will form a basis for the selection of farms in the dairy farming areas for case studies of organization and management. The schedules for seven counties, which comprise a total of 134 farms, were sent to the Washington office for tabulation. Cards have been prepared for 129 farms in Worcester, Franklin, Hampshire and Hampden counties, and contain physical and financial factors of the farm organization and operation for one year.

Case studies of the organization and management of three farms in the western Middlesex and eastern Worcester county area have been started. These farms have dairy, poultry, and orchard enterprises in their organizations and it is planned to determine the relationship between these enterprises under the three sets of conditions found on the farms.

An Economic Study of Secondary Milk Markets in Massachusetts. Group I--Connecticut Valley. (A. A. Brown, C. R. Creek, and J. E. Donley.) The supply side of the market has been emphasized during the past year. Location of most Massachusetts producers within the milkshed has shown a clustering of dairy farms in groups; a clustering which at present appears to be the result of natural conditions. One of these groups lies to the southwest of the Springfield market in the towns of Southwick and Agawam.

In 1935 the average daily deliveries of most of the producers in the Southwick-Agawam section were from 90 to 120 pounds; the average net price 2.40 per hundredweight. This situation indicates that the difficulties of the dairy farmer are due more to a small volume of sales than to a low price. In fact, with such

a small volume of sales, the practical limits to which prices might be raised would offer little relief.

The transportation of milk from farms to city plants is poorly organized and costly to producers. Ninety-four farmers shipped milk to ten different dealers in May 1935, the milk being hauled on ten different trucks. Although none of the producers lived more than 18 miles from his most distant dealer, the trucks traveled 255 miles. Rates for cartage ranged from 20 to 80 cents per hundredweight, with most of the farmers paying 30 to 35 cents. The sole principle applied in most instances in determining rates must have been "charge what the traffic will bear." Milk cartage is essentially monopolistic in this section. As such it might be subject to the authority of the Massachusetts Department of Public Utilities or the Massachusetts Milk Control Board. An equitable and logical rate structure based on distance from market by zones and location would materially increase the efficiency of cartage and remove the cartage rate from the field as a price lever. Without materially affecting existing producer-distributor relationships, routes could be so reorganized as to reduce the mileage traveled by 40 percent and the number of routes to six.

Use of butterfat standards is general throughout the market process. The minimum legal butterfat test in Massachusetts is 3.35 with minimum total solids of 12 percent. In order that milk may test 12 percent solids it must contain a minimum of 3.65 percent butterfat. Dealers' purchases are for the most part on a 3.7 percent basis. Sales are generally on a 4 percent basis. Lack of uniformity in butterfat standards of purchases and sales is most serious. Prices to producers are largely determined on the ratio of purchases to sales irrespective of test. With sales being made at a higher test than purchases, the ratio is inaccurate and discriminating against producers. The situation can be corrected by utilizing milk equivalent volumes of the same standard.

DEPARTMENT OF AGRICULTURAL ENGINEERING

C. I. Gunness in Charge

Cold Storage of Cranberries. (C. I. Gunness, H. J. Franklin, and C. R. Fellers.) A study on the storage of cranberries was started in the fall of 1936. Berries were stored in four typical storages, such as are commonly used by growers, and in addition berries were stored in a refrigerated storage at 30°, 35°, and 50°. The losses in the various storages are shown in Table 1.

TABLE 1.—Storage Losses in Percent, 1936-1937

Storage Conditions	30°	35°	50°	Average of Common Storages
Early Black, picked Sept. 9:				
Stored Sept. 9-Nov. 10.....	3.9	4.7	6.2	11.4
Stored Sept. 9-Nov. 30.....	9.6	4.0	7.7	17.3
Early Black, picked Sept. 25:				
Stored Sept. 25-Nov. 10....	4.5	5.3	9.8	18.2
Stored Sept. 25-Nov. 30....	12.8	10.9	18.4	29.6
Howes, picked Sept. 25:				
Stored Sept. 25-Nov. 30....	2.7	4.3	9.9	13.9
Stored Sept. 25-Jan. 31....	32.6	16.5	26.2	39.5
Howes, picked Oct. 15:				
Stored Oct. 15-Nov. 30.....	4.2	3.8	7.8	10.0
Stored Oct. 15-Jan. 31.....	17.1	17.5	27.6	33.4

The Early Black berries picked on September 9 were quite "green" in appearance and not in prime condition for sale. Those stored at 50° colored very satisfactorily in storage, while those stored at 30° and 35° had changed but little during the storage period. Those held in common storage had colored slightly more than those held at 30° and 35°, but far less than those stored at 50°. This was true in spite of the fact that the temperature in the common storage rooms averaged considerably higher than 50°.

Early Blacks picked on September 25 were well colored, so there was but slight opportunity for further coloring. The berries stored at 50° did, however, show deeper reddish color than any of the other samples.

The observations in regard to coloring of Early Blacks were duplicated on Howes. Those picked "green" colored materially more at 50° than at other temperatures, and the same tendency was noticed on those which were well colored when picked.

An experimental storage was provided for the 1937 crop, with facilities for holding berries at 35°, 40°, 45°, and 50°. Berries were stored at these temperatures, as well as in three common storages. The storage losses are given in Table 2.

TABLE 2.—Storage Losses in Percent, 1937-1938

Storage Conditions	35°	40°	45°	50°	Average of Common Storages
Early Black, picked Sept. 9:					
Stored Sept. 9-Nov. 10.....	3.8	3.4	3.3	5.5	11.8
Stored Sept. 9-Nov. 30.....	5.5	5.9	8.0	10.4	18.3
Early Black, picked Sept. 25:					
Stored Sept. 25-Nov. 10....	1.4	1.7	3.1	3.9	6.8
Stored Sept. 25-Nov. 30....	2.9	4.5	6.3	8.1	11.9
Howes, picked Sept. 25:					
Stored Sept. 25-Nov. 30....	3.1	3.3	4.4	5.1	7.2
Stored Sept. 25-Jan. 31....	10.6	11.5	12.8	13.3	12.3
Howes, picked Oct 15:					
Stored Oct. 15-Nov. 30.....	1.9	2.5	3.0	4.3	4.2
Stored Oct. 15-Jan. 31.....	11.4	12.2	10.2	11.8	10.8

Coloring of the various lots of berries in storage in 1937 was very similar to that in 1936. There was no appreciable difference in coloring in berries stored at 45° and at 50°, but both these lots were more highly colored than any of the other lots. The development of color in storage was naturally most noticeable on berries which were picked "green."

A study of the results obtained would seem to justify the following conclusions:

1. Minimum storage losses will occur if berries are held at 35°.
2. "Green" berries can be colored most satisfactorily at a temperature of 45°.
3. Storage losses can be reduced from 5 to 10 percent by holding berries at from 35° to 45°, as compared with storage in the ordinary screenhouse.
4. The reduction in storage loss through the use of mechanical refrigeration will naturally be greater on berries harvested early than those picked late. Temperatures in the ordinary screenhouse are high in the early part of September but drop appreciably by the first of October.

Apple Storage Investigation. (C. I. Gunness.) The work on apple storages during the past year has been confined to observations on the behavior of refrigeration plants using low pressure gases, such as methyl chloride and Freon, with blowers equipped with copper fin-type coils. Where blowers are of ample size, they have given satisfactory results in defrosting, particularly inasmuch as most

farm storages are operated at a temperature a few degrees above freezing during the loading period.

Low-lift Pumps for Cranberry Bogs. (C. I. Gunness.) In the last annual report it was stated that tests had been conducted on a low-lift pump designed particularly to meet the needs of cranberry growers. During the past summer additional tests on this same pump were made at different speeds. The data obtained from these latter tests serve to aid the grower in the selection of speeds to meet his needs as affected by available power and head and capacity requirements.

DEPARTMENT OF AGRONOMY

Walter S. Eisenmenger in Charge

Tobacco Projects. (Walter S. Eisenmenger and Karol J. Kucinski.)

Cropping Systems. Tobacco grown following other crops is frequently infected with a disease known as brown root-rot. Studies have shown that the chances for serious infection are much less following certain crops than when tobacco follows certain other crops. It would seem, therefore, that the most satisfactory control for the disease on tobacco grown in rotation is to precede tobacco with a crop which will reduce the chances of serious infection to a minimum. Since the last report, the tobacco crop of 1936 has been sorted, and additional information has been obtained as to the quality of the tobacco.

The yield and quality of the tobacco grown on manure was better than that grown with any of the different cover crops. The cover crops used, however, were not injurious to the yield and grade of tobacco. From general observation it was found that tobacco, when it was planted following a 2-year-old hay sod, did better with respect to yield and quality than when it followed a 1-year-old hay sod.

Spacing Experiment. The experiment to determine the comparative effects of different spacing of plants upon the yields and quality of tobacco produced by a larger-growing strain and by a smaller-growing strain of Havana seed tobacco was continued in 1937, according to the plan of experiment used for the purpose in 1936. Planting distances of 36, 39, and 42 inches between rows were used in combination with 12, 15, 18, 21, and 24, and 27 inches between plants. For both years in every combination of planting distances, the larger-growing strain produced a greater yield per acre and the crop index was substantially better. It was found that the quality of the tobacco was perhaps a little better when the plants were planted 24 inches apart in the 36- and 39-inch rows, and 18 inches apart in the 42-inch rows. On the other hand, the crop index, which is the product of both the yield and quality, showed up favorably and nearly equal when the tobacco was planted with 18 inches between plants and 36 inches between rows; 15 inches between plants and 39 inches between rows; and 12 inches between plants and 42 inches between rows. From the data collected, field observations, and practicability of handling of the tobacco in the field, especially with the larger-growing strain, it seems that perhaps the most favorable results could be obtained when the plantings are made with 18 inches between plants and 39 inches between rows. This conclusion is drawn from only 2 years' experimentation.

This experiment should be carried out for a longer period of time before any definite conclusion can be stated.

The Effect of Plants Grown in the Field on the Subsequent Tobacco Planted in Rotation. (Walter S. Eisenmenger and Karol J. Kucinski.) It has been a conjecture of the writers that there was a possible relationship between the botanical species and rate of ammonification and nitrification of plant tissue and the capacity to induce brown root-rot when different plants were grown in rotation with tobacco.

All the grasses tried with the exception of red top are conducive to the occurrence of the trouble. Red top decomposes the most slowly of all the grasses used in rotation.

The *Solanaceae*, potatoes, tomatoes, etc., do not seem to induce the trouble. They decompose exceedingly rapidly to ammonia and nitrate nitrogen. Ragweed and horseweed decompose fairly rapidly, and do not induce the malady.

In 1936, the following varieties of plants were planted in a field, there being 4 plots of each: horseweed, alfalfa, Canada bluegrass, Kentucky bluegrass, sweet clover, orchard grass, red clover, rye, wheat, artichoke, red top, ragweed, gladiolus, turnip, tomato, pepper, cabbage, squash, sudan grass, sorghum, buckwheat, carrots, millet, and seaweed (applied). The relative rate of ammonification and nitrification of these plant tissues is known from previous experiments.

This year tobacco was planted where these plants were grown in 1936. The following table represents the yield and quality of the tobacco grown after these different crops.

Average Yield and Quality of Tobacco

Preceding Crop	Pounds per acre	*Grade Index	*Crop Index
Tobacco	2125	.534	1135
Horseweed	2099	.495	1039
Alfalfa	2049	.499	1022
Canada bluegrass	2093	.510	1067
Kentucky bluegrass	2062	.509	1050
Sweet clover	2089	.524	1095
Orchard grass	2124	.500	1062
Red clover	2051	.494	1013
Rye	2097	.504	1057
Wheat	2187	.506	1107
Artichoke	2044	.510	1042
Red top	2160	.525	1134
Ragweed	2037	.475	968
Gladiolus	2034	.478	972
Turnips	2006	.494	991
Tomatoes	2143	.492	1054
Peppers	2238	.477	1068
Cabbage	2129	.508	1082
Summer squash	2245	.491	1102
Sudan grass	1936	.487	943
Sorghum	1853	.474	878
Buckwheat	2106	.499	1051
Carrots	2127	.496	1055
Seaweed	2643	.443	1171
Millet	2143	.507	1082

*The explanation of grade index and crop index will be found on page 21. The relative values used in 1937 are not identical with those used in previous years but are very similar.

The plants of the grass family were variable in their effect on subsequent tobacco yields, while the legumes and Solanaceae were more consistent. The

latter family seem to have the virtue of being conducive to a good yield of tobacco when they precede tobacco.

Distribution of Nitrogen in Soils Mixed with Different Plant Tissues and Allowed to React for Two Months. (Walter S. Eisenmenger.) Tobacco planted in rotation with corn and timothy is frequently subject to brown root-rot, while tobacco following tobacco or certain weeds, as ragweed or horseweed, seems less susceptible to the disease.

It was found that tobacco, ragweed, and horseweed, when placed in the soil, decomposed more rapidly and with a higher rate of nitrification or ammonification than did red top, corn, and timothy. Clover, when placed in the soil, also had a high rate of ammonification and nitrification, but it was similar to timothy and corn in causing the brown root-rot to appear when planted in rotation with tobacco. The intial rate of decomposition, therefore, is not the only indicator of this trouble.

Clover, timothy, corn, and red top are relatively high in lignin, while tobacco, ragweed, and horseweed are relatively low in lignin. Those plants which are high in lignin, or which maintain their physical structure fairly well during winter weather, are the ones which are least desirable for crops in rotation with tobacco.

Application of Calcium Cyanamide to Overcome the Immediate Harmful Effects of Ligneous Tissue. (Walter S. Eisenmenger and Karol J. Kucinski.) Attempts were made to overcome the bad effects which the residual portions of certain preceding crops have on tobacco. Tobacco plants seem exceptionally sensitive to the effects of the slowly decomposing portions of certain crop plants in the soil.

Applications of nitrogen in the form of calcium cyanamide were made in the fall to plots of corn, red top, orchard grass, and timothy. Similar plots which received no nitrogen were used as check plots. The red top, orchard grass, and timothy plots were two-year-old sods of the respective grasses. Immediately after the nitrogen was applied, all of the plots, including the checks, were plowed under and seeded to a cover crop of rye. The following spring, tobacco was planted on all of these plots.

Plot Treatment	Yield and Quality of Tobacco		
	Acre Yield Pounds	Grade Index	Crop Index
Cornfield			
Plowed — Check	1837	.489	898
500 lb. per acre of calcium cyanamide added before plowing	2169	.555	1203
Two-Year-Old Red Top Sod			
Plowed — Check	1782	.508	905
500 lb. per acre of calcium cyanamide added before plowing	2432	.538	1308
Two-Year-Old Orchard Grass Sod			
Plowed — Check	1935	.524	1014
500 lb. per acre of calcium cyanamide added before plowing	1877	.499	937
Two-Year-Old Timothy Sod			
Plowed — Check	1793	.536	961
500 lb. per acre of calcium cyanamide added before plowing	2185	.508	1110

With the exception of the orchard grass plots, the table above shows that the

yields of tobacco and their respective crop indexes were materially increased by the additions of nitrogen before plowing under the preceding crop.

The Use of Nitrogen as an Aid in Decomposing Old Sod. (John M. Zak, Karol J. Kucinski, and Walter S. Eisenmenger.) It is of interest to find out whether the application of nitrogen to old grass sod before it is plowed under will hasten decomposition and thus counteract the bad effects usually experienced when crops are grown on newly plowed old sod. Applications of calcium cyanamide at the rates of 100 and 50 pounds of nitrogen per acre on old sod before plowing in the early spring proved to be effective in hastening decomposition. The yields obtained on the treated area were higher than those obtained on the check area of sod which received no nitrogen before being plowed. Another area that received the same treatment but was plowed late in the spring showed similar results but to a lesser extent. Determination of ammonia and nitrate nitrogen throughout the growing season showed that the rate of decomposition of the old sod was faster where nitrogen was plowed under. Study of the yields and the chemical analyses shows that the addition of nitrogen to old sods before plowing them under will greatly aid in their decomposition and thus lessen their usually harmful effects.

Rate of Decomposition of Materials Used as Bedding for Animals. (Walter S. Eisenmenger and John M. Zak.) The following bedding materials were analyzed for total nitrogen: southern pine sawdust, southern pine shavings, white pine sawdust, cedar sawdust, hemlock shavings, chestnut sawdust, oak sawdust, birch shavings, peanut hulls, and cacao hulls. A mixture of one half bedding material and one half soil (on a dry-weight basis) was placed in individual crocks and sufficient nitrogen added to each to bring it up to one percent. Determinations are being made of the rate of ammonification, nitrification, and decomposition of lignin.

In another series, cow urine was added to each bedding to the point of saturation, and the material allowed to decompose. Lignin and nitrogen determinations are being made at the beginning and end of the process to study the comparative changes in the various materials.

Magnesium Requirements of Plants. (Walter S. Eisenmenger and Karol J. Kucinski.) Parts of a field known to be deficient in magnesium were used in 1936 to determine the relative response and tolerance of different crops to deficiencies of this element. A mixed fertilizer, containing no calcium and no magnesium was applied to the entire field, and magnesium sulfate and ground limestone were added as shown in the table. Chemical analyses were made of representative samples of crops grown on these plots. The results of analyses of mangels, potatoes, and rutabagas would indicate definitely that wherever magnesium is applied the amount in the plants is increased. Where calcium is applied, not in all instances is the amount increased in the plant.

Plot	Treatment	Analysis on Dry-Matter Basis, Percent					
		Mangels		Potatoes		Rutabagas	
		CaO	MgO	CaO	MgO	CaO	MgO
A	Check	.555	.135	.057	.151	.689	.181
B	Magnesium	.278	.221	.047	.179	.770	.268
C	Magnesium and lime	.364	.201	.065	.194	.819	.228
D	Lime	.637	.157	.066	.147	.698	.173

Different crops were grown on the same plots in 1937 with similar fertilizer treatment. On the basis of field observation alone, the apparent relative tolerance of these crops to the magnesium deficiency, obtained under these conditions, is as follows:

Tolerant		Not Tolerant	
		Abutilon avicennoe (velvet leaf)	
Alfalfa	Rye	Buckwheat	Potatoes
Beans	Soybean	Cabbage	Pumpkin
Beets (red)	Sudan Grass	Corn	Rutabagas
Hollyhock	Sunflower	Cucumber	Tobacco
Millet	Sweet Potatoes	Mangels	Tomato
Peas	Swiss Chard	Muskmelon	Watermelon
Rape		Pepper	

It was also observed that the areas (C and D) which had been continuously limed showed symptoms of detrimental effects. Pronounced signs of frenching of tobacco were witnessed on these two areas, while turnips and rutabagas were a failure even though there was considerable growth of tops.

Soil Treatment for Potatoes. (Walter S. Eisenmenger and Karol J. Kucinski.) The purpose of this experiment was to determine the value of calcium in the form of different compounds, a slight difference in pH, the degree of stimulation due to unusual ions, and the effects of large amounts of organic matter.

A plot of soil was divided into two parts. To one half was applied gypsum at the rate of one ton per acre; to the other half was applied an equivalent amount of calcium in the form of ground limestone. Sweet clover was planted on both parts of the plot and plowed under when in full bloom. Each half was subdivided into smaller plots, and these were treated with various chemicals previous to planting of the potatoes. The following are the comparative yields.

Treatment	Average Yield per Acre Bushels	
	Gypsum	Limestone
Lead sulfate	387	378
Boron	408	393
Zinc sulfate	393	405
Manganese sulfate	399	390
Magnesium sulfate	393	387
Check, with treated seed pieces	372	390
Check, no chemicals	360	396
Mercuric chloride	372	366
"Dubay"	357	384
Cadmium chloride	396	396

A check plot on which no lime or sweet clover cover was used produced 359 bushels per acre.

The results would indicate that the extremely desirable effects of boron, lead, zinc, cadmium, and magnesium are not in evidence. No evidence is at hand as to scab prevention, as scab was not prevalent in any case. In all cases the organic matter improved the yield.

Onion Breeding. (W. G. Colby and Hrant M. Yegian.) The work in onion breeding this past season consisted mainly of combining closely related lines either in open pollinated isolation blocks or under cages with the aid of flies. Seed of some 25 strains, including strains of both late seed and Ebenezer set types, were obtained in this manner. These strains, some of which show promise,

will be compared with commercial strains to determine whether or not the breeding work of the past two years has really produced any strains of a superior character.

Some new breeding work was initiated with seed onions. Some 1200 selected bulbs of a late seed strain and 300 selected bulbs of an early seed strain were selfed. This material will serve as foundation stock for a new breeding program for each of these two types of seed onion.

Pasture Experiments. (W. G. Colby.) The schedule of mineral fertilizer applications was maintained on plots in six permanent pastures in Worcester County. In addition to the regular mineral top-dressing treatment, one plot in each of four of the pastures received a heavy top-dressing of manure over one half and a heavy application of a complete fertilizer over the other half. In the center of each half, a small area (2′ x 3′) was spaded to a depth of six inches. The whole experimental area, including the spaded plots, was then seeded with a mixture of wild white clover and Ladino clover at the rate of three pounds to the acre. A cage was placed over the spaded areas to prevent grazing of the young clover seedlings.

The response to the top-dressing applications of mineral fertilizer was evident but was no more pronounced than in previous years. The response to manure as a top-dressing appeared to be greater than the response to mineral fertilizers, but in no case was the difference great. In the small area which was spaded, on the other hand, a dense growth of clover was obtained on both the "complete fertilizer" side and on the "manure" side of the plot. In fact, the clover seeding caught in only those small areas which were spaded. Elsewhere over the experimental area, only a few weak plants resulted from the seeding operation. From these trials, it is obvious that the physical condition of the soil in permanent pastures, as well as the supply of available plant food elements, is an important factor in influencing the growth of pasture herbage.

Breeding Perennial Pasture Plants. (W. G. Colby and Hrant M. Yegian.) Breeding work with perennial pasture plants is for the most part still in the inventory stage. Studies are being carried on to determine the range of hereditary variation that exists in our native pasture legumes and grasses, and studies are also being made of the environmental adaptability as well as the range of hereditary variation of foreign strains of pasture plants.

Some actual breeding work was begun with Ladino clover by planting a nursery of 2,500 spaced plants, grown from seed. The selection of a Ladino clover strain, possessing greater winter hardiness, is the principal object of this experiment.

Effect of Fertilizer Ratios on Mowings. (Karol J. Kucinski and Walter S. Eisenmenger.) This experiment is a continuation of one reported previously. It seemed desirable to find out whether the quality and yield of the forage can be improved and the life of the mowing prolonged by the use of fertilizers. A mixed fertilizer with a varying ratio of nitrogen, phosphoric acid, and potash, was used. Comparisons have been made by maintaining two of the nutrients at a constant level and varying the third. Data accumulated for several years have shown a distinct response to increments of nitrogen and potash. Little or no benefit was derived from applied superphosphate.

The rainfall being plentiful last spring, the response to nitrogen and potash was in line with those of previous years. In the case of phosphoric acid, greater yields were obtained only when the higher level of phosphorus was used.

Proportion of Mixtures Used in Seeding for Hay. (Ralph W. Donaldson, Karol J. Kucinski and Walter S. Eisenmenger.) Trials of thirteen different hay

seeding mixtures are being maintained, from which yield data for the first two seasons have been obtained. The mixtures include alfalfa, red clover, timothy, orchard grass, and red top, used in varying combinations to make 21-pound mixtures, ranging from one with no alfalfa up to one with only alfalfa. The thirteen different mixtures are replicated three times at the 21-pound rate, and twice each at 17- and 13-pound rates of seeding per acre. Two cuttings each of the two seasons have been harvested on an area 5 x 90 feet from each of the 99 plots, and recorded as air-dry yields per acre.

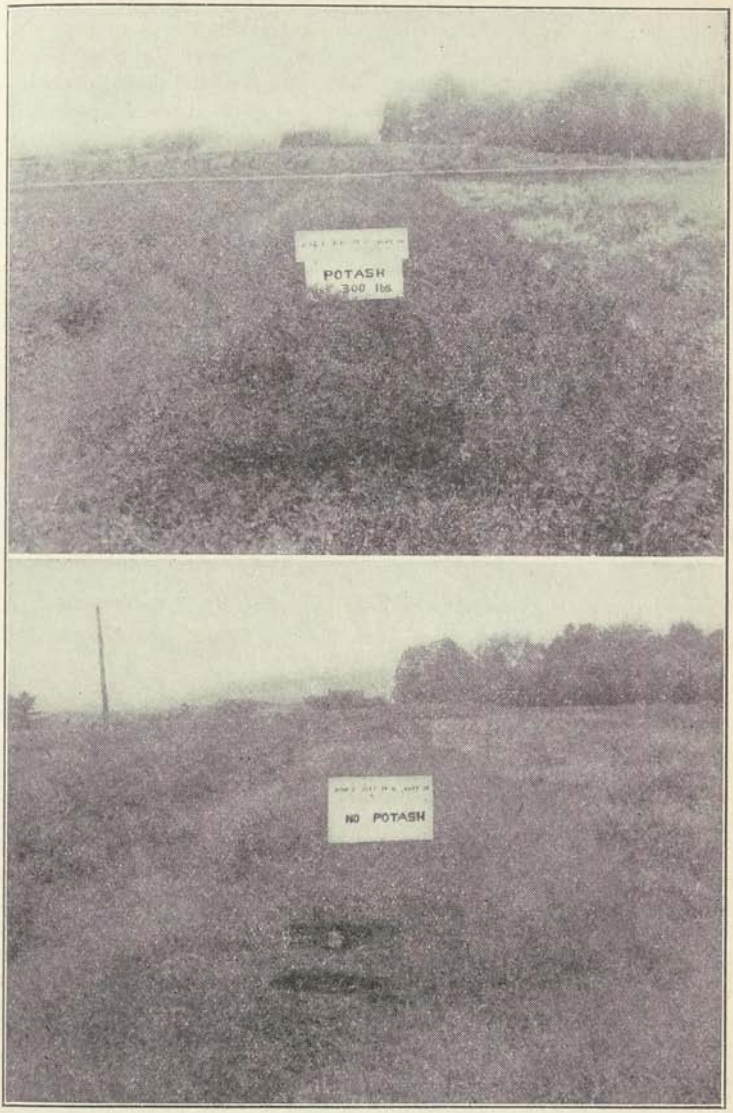
Results show a consistently lower yield for each of the two seasons from all the thirteen mixtures seeded at the 13-pound rate, which averaged 8060 pounds of hay compared with 8981 pounds harvested from the 21-pound rate of seeding—a difference of nearly one-half ton per acre. The 17-pound and the 21-pound rate of seeding showed no consistent difference, although the average yields favored slightly the 21-pound rate.

The differences in yield among the thirteen seed mixtures indicate an advantage from mixtures consisting of one-third to two-thirds alfalfa, along with timothy, clover, and possibly small amounts of red top. Consistently, the two lowest-producing mixtures have been the extremes, no alfalfa and only alfalfa, which have yielded three-fourths of a ton less hay than several other mixtures. Orchard grass, while comparing favorably with timothy in point of yield, appears far less desirable for use in these mixtures, owing to its earlier maturity and some tendency to dominate the stands.

The Effect of Time of Cutting on Yields of Alfalfa and the Use of Potash in Preventing Winterkilling of Alfalfa. (Karol J. Kucinski, Walter S. Eisenmenger and Ralph W. Donaldson.) Mowings of 2-year-old alfalfa were made at definitely spaced intervals of time to determine the best management practices for alfalfa growing. Eight plots were cut three times, and four plots were cut twice per season, beginning in early June and extending to late September. This year, as in 1936, the higher yields of alfalfa were associated with those plots having a schedule of three cuttings. The highest yield was obtained when the first cuttings were made on June 7, the next on August 2, and the last on September 3. In the schedules with two cuttings, the total yields were not as great as any of the total yields from schedules with three cuttings, but the stand of alfalfa in the fall where two cuttings were made was superior to that where three cuttings were made.

In the early summer of 1936, an application of 300 pounds of muriate of potash was made to a portion of each plot, while the other portion received none. In each schedule of cuttings, where the three dates of mowing were relatively close together or where the last mowing was very late in the season, there was a definite winterkilling of the alfalfa plants on that portion of the plot which had not received the application of muriate of potash. The accompanying photograph taken from one of the plots shows that the portion of the plot which received an application of potash withstood the elements of weather and produced a thick stand of fine alfalfa, while on the part not receiving any potash the alfalfa was entirely winterkilled and has been replaced by weeds.

Alfalfa Variety Tests. (Walter S. Eisenmenger and Karol J. Kucinski.) In cooperation with the United States Department of Agriculture, tests are being conducted with fifteen varieties of alfalfa. The comparatively heavy rainfall during the past summer resulted in larger yields for this year than for 1936, except in a few cases. Hardigan and Ontario variegated varieties gave excellent yields in 1936 and were again outstanding in 1937. Varieties from southern states and countries are not adapted to conditions in Amherst.



The Effect of Potash on the Winterkilling of Alfalfa.

Testing Varieties of Corn for Grain and Silage. (W. G. Colby and Ralph W. Donaldson.) A test of corn varieties begun in 1935 was continued in 1937. Yield data of stover and shelled grain as well as information on time of maturity and habit of growth were obtained on 125 corn varieties. These included Flint and Dent varieties of local and regional importance and also a large number of the best "hybrid" strains from the chief corn-producing sections of the country.

For use in the Connecticut Valley, the varieties tested can be divided into three general groups: early grain, late grain and silage, and silage varieties. The local Flint and Dent varieties together with varieties grown for grain in New York, Michigan, Wisconsin, and Minnesota comprise the early grain group. The grain varieties from Iowa, Illinois, Indiana, Ohio, Pennsylvania, and New Jersey fall into the next or late grain and silage group. The third group is made up of those very late-maturing varieties mostly from the Southern States which mature little if any grain and can be considered only for use as silage.

The best yields of grain and stover can be expected from the late grain and silage varieties. In years of favorable growth and when the date of the first fall freeze is average or later than average, most of these varieties will mature grain in Amherst. However, if the season's growing conditions are unfavorable for corn, these varieties will not mature before frost and can only be used for silage.

If a reliable grain-producing variety is wanted, an early-maturing strain must be selected, which, although not yielding as will later-maturing strains, can be depended upon to consistently reach maturity before the first fall freeze.

Potato Variety Tests. (Ralph W. Donaldson, Walter S. Eisenmenger and Karol J. Kucinski.) Yield tests of ten potato varieties were continued this year on the experiment station farm. Each plot received six applications of Bordeaux mixture, 5-5-50. One series of plots received gypsum ($CaSO_4$) at the rate of one ton per acre, and the other series received the equivalent amount of calcium in the form of ground limestone ($CaCO_3$). Following are the yields per acre in bushels.

Variety	Gypsum Treatment	Limestone Treatment	Average
Green Mountain	382	407	395
Chippewa	384	322	353
Russet Rural	378	301	339
Warba	287	251	269
Katahdin	257	271	264
Houma	261	—	261
Irish Cobbler	284	216	250
Bliss Triumph	235	263	249
Golden	212	201	207
"Idaho Baker"	189	202	195

The Comparative Nutritive Effects of Copper, Zinc, Chromium, and Molybdenum. (H. Robert DeRose, Walter S. Eisenmenger, and Walter S. Ritchie.) Tomatoes, buckwheat, and barley were again grown in crocks in pure white sand which had been washed with aqua regia and then water and heated to 100° C. Knop's solution was used, and the crocks were so regulated as to drain at the rate of 1 liter in 24 hours. All salts used were recrystallized, and distilled water was redistilled from Pyrex glass. Copper was used at the rate of 0, .05, .15, .50, 1.0, and 5.0 parts per million; and zinc at the rate of 0, .05, .15, .50, 1.0, 10.0, and 20.0 p.p.m.

Again it was clearly shown that both copper and zinc had a stimulating effect on tomato plants when used in .05 and .15 p.p.m. concentrations. This was

indicated by the height and total dry matter of the plants. In the case of buckwheat, the lower concentrations of copper and zinc indicated slight stimulation.

The tomatoes which were treated with molybdenum in concentrations of 0, 1.0, 5.0, 10.0, 20, 40, and 80 p.p.m., indicated that any concentration above 1 p.p.m. was toxic to the plants. One part per million gave a little better growth than the control, while the plants receiving the higher concentrations were badly stunted. The plants which received amounts of molybdenum greater than 1 p.p.m. in all cases had petioles which were devoid of leaflets for several weeks. Concentrations of 1 p.p.m. and 5.0 p.p.m. of molybdenum had a decided stimulating effect on buckwheat, while concentrations greater than 5 p.p.m. showed toxicity. When barley was thus treated with molybdenum in the same concentrations as tomatoes, it was definitely indicated that 20 p.p.m. and 40 p.p.m. gave the better growth as judged from the height and general vigor of the plants, as well as the total dry weight.

From preliminary results with chromium in concentrations of 0, .50, 1.0, 10, 20, 40, and 80 p.p.m., all of the tomato plants receiving the element showed signs of toxicity.

The chemical analyses of the leaves, roots, and stalks or stems of the various plants are now in process.

Borax Trials on a Market Garden Soil. (Ralph W. Donaldson and Robert E. Young.) A 30-pound rate of borax, applied broadcast prior to planting on Gloucester soil of pH 6.4, eliminated stem crack of celery, resulting in excellent yield and grade, compared with severe cracking and poor growth on no-borax plots. Side applications of borax at the same rate, applied September 2 on untreated rows where crack symptoms first appeared August 20, effected recovery and subsequently produced celery of similar yield and grade.

Crops grown in these trials, conducted by John Handy, County Agent, Concord, Massachusetts, included Golden Plume and Pascal celery, spinach, beans, beets, cauliflower, and rutabagas. Aside from celery, the only crop showing response to borax was rutabagas in which dark center, present on the check plots, was absent on the borax plots initially treated.

Borax Trials. (Ralph W. Donaldson, W. G. Colby, and Walter S. Eisenmenger.) Effects of borax applications, made May 20, at 15-, 30-, 60-, and 120-pound rates per acre broadcast on Plymouth Sand soil type of pH 4.6, were observed on the following crops seeded June 7: beans, beets, corn, carrots, radish, and rutabagas. In addition to a uniform treatment of fertilizer, portions of all plots received limestone at 1000- and 3000-pound rates.

Germination was not noticeably injured on any crops on the 15- and 30-pound rates. Beans were entirely killed on higher rates, but the other crops showed but little injury on the 60-pound rate, and some plants of each crop survived on the 120- pound rate, radishes being most severely injured and rutabagas the least.

Owing to development of weeds, final yield data were abandoned, but late observation showed that best growth of all crops except beans occurred on the 60-pound rate, with boron-deficient turnips appearing only on the check plots.

Field trials in the Connecticut Valley, with borax alone and in a mixture comprising other minor elements applied to onion crops, indicated no control for onion blast.

Weedicidal Properties of Calcium Cyanamide. (Hrant M. Yegian and Lawrence S. Dickinson.) Studies are being made of the weedicidal properties of calcium cyanamide when used in soils previous to sowing seeds of turf grasses and its effect on surface weed seeds in established lawns.

The effectiveness of the chemical appears to be distinctly correlated with the soil moisture, best results being obtained with low rates of application in wet soils. Control is not perfect, but germination of the few surviving weed seeds seems to be sufficiently retarded to permit grass seed, sown eight days after treatment, to make well-established turf.

In established lawns heavily infested with crab grass seed, enough of the seeds were killed to warrant further studies of rate and technique of application.

Increasing the Iron Content of Hay Grown on Soils Producing Nutritional Anemia in Massachusetts Livestock. (Karol J. Kucinski, John G. Archibald and Walter S. Eisenmenger.) During the winter of 1933-34 a peculiar disease of cattle called "neck ail," which had given considerable trouble for a good many years to Massachusetts farmers living around Buzzards Bay and vicinity, was first brought to the attention of the Agricultural Experiment Station.

After a careful investigation, the ailment was diagnosed as a "nutritional anemia." If affected animals were treated with a "drench" of ferric ammonium citrate, recovery to a healthy condition was soon noted. From preliminary work, it was found that both the soil and the grass grown upon it were exceedingly low in iron. It appears, therefore, that the malady is due to the lack of available iron in the sandy soils of this affected region which makes the iron content of the forage very low.

Typical soils of the affected region, known to have produced nutritional anemia in cattle, were brought into the greenhouse, and known amounts of iron salts added to them. Mixed hay grasses were grown on them and analyzed for iron content. They showed an increase of 21.8 to 64.9 percent over the amount of iron found in the controls. The increase of available iron (5 percent oxalic acid extract) in these same soils after treatment ranged from 27.4 to 651.5 percent over the controls.

The Absorption by Food Plants of Chemical Elements Important in Human Nutrition. (Walter S. Eisenmenger and Karol J. Kucinski.) Lettuce and cabbage were grown on soil to which the following cations were added at the rate of 500 parts per million per individual plot; sodium, potassium, magnesium, and calcium. The anions, chlorine, bromine, iodine, sulfate and phosphate, were used on additional plots at the rate of 200 parts per million.

An endeavor is being made to ascertain whether or not those elements found in relatively large amounts in sea water are taken up by the plant in greater quantities than those present in relatively low amounts in sea water.

COOPERATIVE TOBACCO INVESTIGATIONS

Conducted by the Bureau of Plant Industry, United States Department of Agriculture, in Cooperation with the Massachusetts Agricultural Experiment Station

C. V. Kightlinger, U. S. D. A., In Charge

Black Root-Rot. (C. V. Kightlinger.) The purpose of this project is to find strains of Havana Seed tobacco which may be acceptable under Connecticut Valley conditions for resistance to black root-rot and for type of plant, type and quality of leaf, gross yielding capacity and other properties that may be necessary to make the strains acceptable to tobacco growers and cigar manufacturers. It was proposed to accomplish this by a fourfold plan or such portion of the plan as might be necessary; viz., (1) To breed and test numerous strains of Havana

Seed comparatively by means of well-arranged, small plot experimental tests and to select the most promising strains for further and more extensive testing; (2) to conduct the more extensive tests cooperatively with successful tobacco farmers and with cigar manufacturers, to learn the merits of the strains in practical production and commercial uses, and to obtain the criticisms of these men and also their suggestions for the improvement of the strains from their point of view; (3) to improve the strains, if possible, by further selection and breeding, to correct the faults which were detected in the previous cooperative tests; (4) to conduct further cooperative tests with successful tobacco farmers and with cigar manufacturers to obtain, if possible, their approval of the strains.

The results of the first phase of the work were promising. They have been given in previous reports. The complete results of the second phase of the work have not been learned, but the portion of these results that are known are also promising. They have shown the strains to possess merit, but to need improvement in certain respects in order to be entirely acceptable from the point of view of the cigar manufacturers. As a result, the project is now in its third phase of the proposed procedure.

Reductions in Yield and Quality of Tobacco Caused by Mosaic. (C. V. Kightlinger.) Experiments were begun in 1936 to make comparative determinations of reductions in yield and quality of Havana Seed tobacco caused by common tobacco mosaic whose periods of infection were inoculated for at successive 15-day intervals, extending from as soon after time of setting to as near topping time as conditions would permit. Uniform conditions of culture, harvesting, and curing of the tobacco were employed.

The tobacco for these experiments was set June 5 and was harvested August 23. Topping was done August 5. The inoculations for mosaic were made artificially by rubbing the leaves of the plant to be inoculated with expressed juice of mosaic diseased tobacco plants. The dates of inoculation were June 10, June 25, July 10, and July 25. Two replications of the experiment were made.

The average experimental results obtained in 1936 are as follows:

Dates of Inoculation	Average Yield per acre (pounds)	Average Grade Index	Average Crop Index
Control 1	1991	.395	786
June 10	1545	.322	497
June 25	1624	.336	546
Control 2	2006	.393	788
July 10	1709	.348	594
July 25	1840	.372	684
Control 3	2035	.402	818

Grade index, as used here, is a number expressing the grading quality of tobacco produced under the conditions of the experiment. It is based upon the percentage yield of each grade of tobacco and the relative values of these grades given below:

Lights	1.00	Long darks (19″ and longer)	.30
Mediums	.60	Dark stemming (17″ and shorter)	.20
Long seconds (19″ and longer)	.60	Brokes	.10
Short seconds (17″ and shorter)	.30	Fillers	.10

The grade index is derived by multiplying the percentage of each grade of tobacco by the respective rating of the grades, given above, and adding the products.

Crop index, as used here, is a number expressing the crop value of tobacco produced under the conditions of experiment. It is based upon the gross yields of tobacco in pounds per acre and the grade index of the tobacco. Crop index is derived by multiplying the gross yield of tobacco in pounds per acre by the grade index of the tobacco.

Grade index and crop index and the adopted relative values of the different grades of tobacco, as used here, do not necessarily represent current commercial prices of tobacco.

With respect to the average experimental results given above for the several items of data, it should be stated that the respective results for the two replications of the experiment were very similar, with only small differences existing between corresponding items of data.

DEPARTMENT OF ANIMAL HUSBANDRY

Victor A. Rice in Charge

The Effect of Feeding a Vitamin A Concentrate on Reproduction in Cattle. (J. G. Archibald, V. A. Rice, and C. H. Parsons.) This project was brought to completion during the year. A preliminary report of results was given at the annual meeting of the Eastern Section, American Dairy Science Association in September. Conclusions drawn at that time are as follows:

Taken individually none of the differences between the groups are significant. However, the evidence as a whole shows a slight trend in favor of the group which received the vitamin A concentrate. Twenty comparisons of various phases of reproductive function are available for the duration of the experiment. Of these, eleven favor the group receiving vitamin A concentrate, six favor the other group, and three are evenly divided.

The effect of the supplement is reflected principally in the birth weight of the calves dropped during the experiment and in a much smaller percentage of still-born calves.

Since these cattle probably were on better than average rations, it is conceivable that the vitamin supplement might show a more positive effect in some herds, especially where silage is not fed and the hay is of poor quality. The indiscriminate feeding of such supplements regardless of conditions should not be practiced. The individual farmer should study his own particular conditions and decide for himself whether grain mixtures containing vitamin A concentrates are worth the additional cost, bearing in mind always that if for winter feeding he has plenty of early-cut, properly cured hay and well-made corn silage that has not been frosted, and if he has good pasturage in the summer, he will not need to supply additional vitamin A to his cattle.

The Effect of Complex Mineral and Vitamin Mixtures on Milk Production, General Health, and Reproductive Efficiency in Dairy Cattle. (J. G. Archibald.) This project has been continued throughout the year in accordance with the plan outlined in last year's report. Regular quarterly visits have been made to each of the three herds in order to grade the cattle for general appearance and condition, and to exercise proper supervision over the work and the keeping of records. The feeding trials will be terminated during the coming year and the records will then be studied in detail.

A Study of the Mineral Elements of Cows' Milk. (J. G. Archibald, V. A. Rice, and C. H. Parsons.) Supplemental calcium in the form of ground limestone fed to a group of eight cows in the college herd during the winter of 1936-37 did not increase the calcium content of their milk. On the contrary the average calcium content of monthly samples of milk taken in each month from November, 1936, through April, 1937, was slightly lower when the cows received the supplemental calcium than when they were on the standard ration, although the difference was so slight that it was not statistically significant.

This season the effect of supplemental phosphorus on the amount of that

element in the milk is being followed in a manner similar to that outlined for calcium in last year's report.

The Effect of Artificial Light on Milk Production. (J. G. Archibald, V. A. Rice, and C. H. Parsons.) This project was seriously interfered with during the latter half of the winter of 1936-37, by the repeated burning out of the special 1000-watt lamps installed for the purpose. The trouble was finally located by the manufacturers of the lights and they are hopeful that the defect has been remedied. Due to partial destruction by fire in September of the building in which the stalls and equipment were located, there has not been an opportunity as yet to test out the improved lights. It is hoped that sufficient repairs will be made before the end of the calendar year to allow the work to proceed.

The small amount of data available shows approximately one percent greater milk production during the 30-day periods when the cows were exposed to the strong light than when they were kept under ordinary conditions as regards lighting. The results need further confirmation before any significance can be attributed to this small increase.

Studies in the Chemistry of Pasture Grass. (J. G. Archibald.) Chemical studies of the grasses grown on the series of plots established in 1930 have been brought to completion with the analysis of the samples obtained in 1936, but the final interpretation of results has not yet been made.

This series of plots was used for palatability tests with cows during the early summer of 1937. The plots were enclosed with a temporary wire fence, and two Jersey cows were turned into the enclosure from about 8:30 a. m. until about 12 noon on each of two successive days at three different times during May and June. The time interval between grazings was determined by the growth of the grass and averaged about 17 days.

A reliable attendant was stationed to watch closely the movements of the cows and to record the time when they started to graze on any given plot and when they left it for another one; also to record any time when they were not grazing. A complete record of each cow's grazing activity and preferences was thus obtained, approximately seven hundred individual observations being recorded. It was planned originally to make further tests in the fall but the growth on the plots did not warrant it. The work will be repeated next year and extended to the second series of plots established in 1934.

While final conclusions cannot be drawn at this time, it is of interest to note that our judgment of the nutritive value of the several species of grasses based on their chemical composition as determined by actual analyses of a large number of samples, is confirmed by the preference shown by these cows. Invariably the cows grazed much more heavily those species having a relatively high content of moisture, protein, and soluble ash, and a relatively low content of crude fiber; they showed scant liking for species relatively high in fiber and relatively low in moisture, protein, and soluble ash; they refused almost entirely one species which has been characterized by a high fiber content over a period of years.

Chemical studies of grasses from the second series of plots referred to above, which was established in 1934 on a very different soil type from the 1930 series, have been continued this year, but at date of writing the analytical work has not been completed.

The Vitamin Content of Certain Pasture Grasses. (W. S. Ritchie and J. G. Archibald. Cooperative with Chemistry.) The laboratory and field work on this project has been completed. (See report of Chemistry Department for details.)

Nutritional Anemia in Cattle in Southeastern Massachusetts. (J. G. Archibald and K. J. Kucinski.) This work has been done in cooperation with the Agronomy Department and with representatives of the Wirthmore feed organization. A paper on the subject, bearing the title appearing above, has been accepted for publication in the *Journal of Dairy Science* but has not yet appeared in print. A summary of the study follows:

A disease of cattle locally known as "neck ail," of long standing in certain localities of southeastern Massachusetts, has been shown to be identical with nutritional anemia of cattle occurring in various widely scattered portions of the world and known by various names. The disease is characterized by emaciation, loss of appetite, and a diminution in the red blood cells and in the hemoglobin content of the blood of affected animals. It is caused by an insufficient amount of iron in the native forage which in turn is due to a very low content of iron in the soils on which the forage is grown. As with cases reported by other investigators, spectacular recovery has followed the administration of iron compounds to the affected animals.

Addition of an iron compound (iron ammonium citrate) to soils from farms where the disease had occurred, resulted in a uniform large increase in the percentage of iron in grasses grown on these soils. This suggests an alternative method for prevention of the disease.

Investigation of the Merits of Molasses-Grass Silage for our Particular Conditions. (J. G. Archibald and C. H. Parsons.) Preliminary work was done on this problem last year. Funds were not available for the erection of a permanent silo, so a temporary silo made from snow fence and building paper was erected in which 35 tons of green grass were preserved with approximately 2300 pounds of molasses. This arrangement proved only partially satisfactory. Due perhaps to inexperience in erecting the temporary silo there was much more waste than is ordinarily the case in the preservation of crops by ensiling. The limited feeding trials possible with the amount of silage available indicated that it was at least as good as dry hay for milk production.

During the present year funds were obtained for the dismantling of a 100-ton silo at the Brooks farm barn no longer in use there, and its re-erection on a concrete base at the main dairy barn. When re-erected the structure was insulated with a special felt base heavy building paper and the whole reinforced with a spiral casing of redwood veneer. This makes a very satisfactory permanent triple-wall silo, for all practical purposes the equivalent of a new structure, at a somewhat smaller cost. In June of this year there were stored in this silo 114 tons of chopped grass mixed with 4 tons of molasses, much of the work being done under weather conditions which made ordinary haymaking impossible. An extensive feeding trial comparing the grass silage with corn silage and also with dry hay for milk production is now in progress and will be continued until the end of the barn feeding season the latter part of April.

Daughters' Records Alone versus Daughter–Dam Comparisons in Predicting Transmitting Abilities of Dairy Bulls. (V. A. Rice.) A previous study of records in the Guernsey breed had indicated that when pedigrees of bulls could be made complete for two generations by including indexes of the bulls therein and records on the cows, the transmitting abilities of these bulls for milk production and percentage of fat could be fairly accurately ascertained. In the previous work the dams' and granddams' records were averaged with their respective sire's indexes and this figure used as the transmitting ability or index of the cows. The index of the immediate sire was averaged with the transmitting index of the dam and .6 of this amount added to .4 of the average of the indexes of the two

grandsires and the transmitting indexes of the two granddams. This sum is called the Prediction or Pedigree index. It is built on indexes which are the result of comparing daughters' production with that of their dams.

Some investigators have claimed that the daughters' records alone are a better measure of the transmitting ability of their sire than is an index. This seems questionable since both sire and dam supposedly contribute about equally to their offsprings' capabilities.

The Jersey breed publishes a tested sire list which gives the average production of the daughters of all bulls with ten or more daughters with records. A study was made of this material to try to determine its prediction value for bulls of the Jersey breed. Thirty-five bulls (the same number as used in the previous Guernsey study) whose pedigree could be made complete for two generations were chosen at random. The sires and grandsires of these bulls were in the tested sire list and the average production of their daughters known. The dams had records and the granddams also had records and their sires were in the tested sire list. The material was used as indicated above to obtain the Prediction or Pedigree index. The records as published in the tested sire list are not corrected to a standard number of milkings per day. The daughters of one bull might have made their records on four-times-a-day milking and those of another bull on twice-a-day milking. This is obviously unfair, so the material was used both in its original printed form and also corrected to a standard three-times-a-day milking.

On the uncorrected basis the composite pedigree index of these thirty-five bulls was 11,684 pounds of milk testing 5.41 percent fat. This is what the daughters of these bulls should have produced if the method is sound genetically and the records complete enough. They actually averaged 10,684 pounds of milk testing 5.37 percent. This is a 10 percent error. The individual errors ranged from −52 to +18 percent. When corrected to standard three-times-a-day milking, the daughters were expected to produce 12,232 pounds of milk testing 5.41 percent fat. They actually produced 11,409 pounds of milk testing 5.37 percent fat; an 8 percent discrepancy with the individual errors ranging from −41 to +13 percent.

In the Guernsey breed, using indexes instead of daughters' records only, the error on the composite thirty-five bulls had been 0.7 percent and the range of individual errors −16 to +14 percent.

The writer then tried various combinations of parts of these Jersey Pedigrees in an effort to find a practical way of using this material to predict what the daughters of a young bull would produce. The results are indicated in the accompanying table.

The task of the breeder is to ascertain, beforehand if possible, the potentialities contained in the germ cells, particularly of breeding bulls. Only in this way does it seem possible to take some of the guess out of breeding operations. From this study it appears that the daughters' records alone are not nearly as efficient for predicting production of the daughters of bulls as are indexes based on a comparison of daughters' records with those of their dams.

Value of Pedigree and Certain Parts Thereof in Predicting Production of Bull's Daughters

Material	Range of Errors	Percentage With Less Than 5% Error	Percentage of Bulls Whose Daughters Exceeded Expectations	Average Error	Correlation Between Indicated Method at Left and Bull's Daughters Average
Guernsey Pedigree Index	−16 to +14	80	70	4.40	=.62±.07
Jersey Pedigree Index (Uncorrected)	−52 to +18	20	20	15.79	=.19±.11
Jersey Pedigree Index (Corrected)	−41 to +13	37	20	12.06	=.41±.09
Jersey Sires' Daus. (Uncorrected)	−40 to +14	20	20	16.01	=.45±.09
Jersey Sires' Daus. (Corrected)	−31 to +14	26	20	12.00	=.54±.08
Jersey Dams' Record	−101 to +28	11	11	27.40	=.18±.11
Jersey Dams' Record Averaged with Sire's Daughters Average	−55 to +16	28	20	15.94	=.28±.10
Jersey Sire's Dau. Average and Dam's Record (Uncorrected)	−67 to +6	9	9	20.34	=.33±.10
Jersey Sire's Dau. Average and Dam's Record (Corrected) Averaged with Sire's Daughters' Average	−43 to +11	26	17	13.70	=.47±.09
Jersey 3 Nearest Sires (Uncorrected)	−43 to +20	31	28	13.43	=.24±.10
Jersey 3 Nearest Sires (Corrected)	−52 to +10	37	26	10.98	=.46±.09
Jersey 5 Nearest Sires (Uncorrected)	−41 to +26	31	37	11.70	=.15±.11
Jersey 5 Nearest Sires (Corrected)	−31 to +15	30	50	9.80	=.43±.09

DEPARTMENT OF BACTERIOLOGY

Leon A. Bradley in Charge

The major part of the research program in bacteriology for this and several preceding years has been the study of the physiology of bacteria of the Coli-Aerogenes group. The Standard Methods of Water Analysis of the American Public Health Association employs the group as an indicator of the sanitary quality of a water supply. It must be pointed out, however, that the Standard Methods procedure is designed primarily to test filtered and treated municipal water supplies. Experience in this laboratory has been that the standard is too rigorous for the wells and springs that supply farms and rural homes. Certain authorities on water bacteriology maintain that, of the Coli-Aerogenes group, only *Escherichia coli* and perhaps closely related intermediates of the group are certain indicators of sewage pollution; and that *Aerobacter aerogenes* and closely related intermediates indicate only surface drainage, and if they indicate sewage pollution at all, it is so remote in time as to be harmless.

This laboratory is frequently faced with the necessity of deciding upon the quality of a water sample which would be condemned on the basis of the bacteriological test, but not on the basis of available information concerning the location, construction, and surroundings of the well or spring in question. The condemna-

tion of a privately owned rural water supply frequently involves a serious financial problem to the owner, and it is for this reason that research in the physiology of the Coli-Aerogenes group was undertaken in the hope that more information could be obtained as to methods of differentiating members of the group, in order that a better understanding of their relative sanitary significance might result.

The Influence of Bile and Bile Salts on Aerobacter Aerogenes. (James E. Fuller.) A preliminary report has been made on this study (Mass. Expt. Sta. Bul. 339, 1937). The study was undertaken to investigate the premise of certain investigators that *Escherichia coli* may become *Aerobacter aerogenes*, and vice versa, as a result of environment. Since bile is an important constituent of the fecal mass in the human colon, it could be an important environmental factor in converting *Aerobacter aerogenes* to *Escherichia coli*, if the premise should be true. Twenty-five strains of *Aerobacter aerogenes*, originally isolated from water, were cultivated for five months in one percent, and in five percent, concentrations of bile and of bile salts (sodium glycocholate and sodium taurocholate). At the end of five months' incubation the reactions of the strains to the differential tests (Voges-Proskauer, methyl-red, sodium citrate, uric acid, and indol production), and their morphology and staining characteristics were unaltered. This research does not lend any support to the premise mentioned above.

The Effect of Bacteriophage on Escherichia coli. (Amedeo Bondi, Jr. and James E. Fuller.) This study, like the one above, was undertaken to investigate the stability of members of the Coli-Aerogenes group. Bacteriophage is an environmental factor which, when it acts on a susceptible bacterial strain, sometimes produces cultures quite different from the parent strain in appearance and behaviour. Several strains of *Escherichia coli* were subjected to the influence of a strain of bacteriophage which was specific for one of the strains, but not for the others. The biochemical reactions (lactose fermentation, indol production, and the methyl-red, sodium citrate, and sodium malonate reactions) were not changed. The strain subjected to the action of its specific bacteriophage yielded atypical colonies on nutrient agar and on Endo's medium. Subcultures from these atypical colonies were resistant to the action of the bacteriophage which had produced them, and were agglutinated by higher dilutions of a specific serum than were cultures of the same bacterial strain before it had been subjected to the action of the bacteriophage.

The Action of the Coli-Aerogenes Group on Erythrosin. (Ralph L. France.) The results of this study are published in *Zentralblatt fur Bakteriologie* II Abt., Bd. 97, 1937.

A Study of the Eijkman Test. (Ralph L. France.) A pure culture study of strains of the Coli-Aerogenes group indicate that the *Escherichia coli* strains are the only ones that produce acid and gas in the Eijkman broth at 46° C. However, certain strains of intermediates and *Aerobacter aerogenes* produce acid, but no gas, at 46° C. Further studies are being conducted to determine the extent of growth of strains of intermediates and *Aerobacter aerogenes* in the Eijkman broth, at 46°, 45°, 44°, and 43° C.

The Tolerance of the Coli-Aerogenes Group for Brilliant Green. (Ralph L. France.) No work has been done on this project since the last report of progress (Mass. Expt. Sta. Bul. 339, 1937). The project will be completed this year.

A Comparative Study of Proposed New Methods and the Standard Methods for Obtaining Bacteria Counts of Milk Samples. (Ralph L. France.) The results

to date indicate that a 32° C. incubation temperature gives more accurate counts than the standard 37° C. temperature. The Bowers-Hucker plating medium does not appear to have any advantages over the standard medium when incubation is at 32° C.

A Comparative Study of Proposed New Methods and Standard Methods for Testing Oysters. (Ralph L France.) This project has been undertaken upon the request of Dr. C. A Perry, referee and chairman of the Standard Methods Committee for Oyster Analysis of the American Public Health Association. Work will be started as soon as a copy of the proposed new methods has been received from the referee.

Influence of Added Iodine and Kelp on Intestinal Flora of White Rats. (W. B. Esselen, Jr., James E. Fuller, and George S. Congdon.) It is generally conceded by authorities that the aciduric bacteria of the acidophilus type are preferable in the intestine to bacteria which decompose protein materials, since the latter produce products which are detrimental to the body when they are absorbed into the blood. This project was designed to study the influence of iodine and mineral elements and their salts on intestinal bacteria.

White rats were fed raw or pasteurized milk, both with and without added iodine. A similar experiment was run with kelp instead of iodine added to the milk. The addition of iodine or kelp,to the milk did not appear to influence the ratio of aciduric to proteolytic bacteria. All of the milk diets increased the percentage as well as the numbers of aciduric bacteria; raw milk without iodine was less effective than were the other milk diets. There was no marked effect on the reaction (pH) of the feces of any of the rats. Gastric acidity of rats on the kelp supplement was higher than that of rats not fed kelp. Kelp in the diet did not significantly influence the amount of urinary phenol (considered indicative of intestinal putrefaction) or of conjugated phenols (considered indicative of the ability of the body to neutralize toxic phenols absorbed from the intestine). This is the completion of the study reported previously (Mass. Expt. Sta. Bul. 339, 1937).

Influence of Added Iodine on the Bacterial Flora of Milk. (George S. Congdon and James E. Fuller.) The influence of added iodine on the bacterial flora of milk was investigated. In addition, pure culture studies were made with bacteria inoculated into sterilized raw milk and into nutrient broth. Tincture of iodine U. S. P., Gram's iodine-potassium iodide solution, and Iodine Suspensoid (Merck) were the forms of iodine employed Gram's iodine solution was a somewhat more efficient germicide than the other two solutions, but it is less stable. Milk with a higher bacteria count required more iodine for its sterilization than did low-count milk. This is the completion of the study previously reported (Mass. Expt. Sta. Bul. 339, 1937).

The Action of Intestinal Bacteria on Ascorbic Acid (Vitamin C). (W. B. Esselen, Jr.) The purpose of this study was to investigate the reported destruction of Vitamin C by certain intestinal bacteria, and to attempt to discover the mechanism of the vitamin's destruction. Pure cultures of the bacteria employed were cultivated in media containing ascorbic acid. The results indicated that, instead of destroying Vitamin C, the bacteria actually exerted a protective action which varied directly with the suitability of the medium for bacterial growth and with the numbers of bacteria present. Lowered pH in the medium was not a factor in protecting the vitamin, and no correlation was observed between the ability of

the bacteria to reduce methylene blue and the stability of the vitamin in their presence. The cultivation of the culture in atmospheres of carbon dioxide and of hydrogen respectively revealed that carbon dioxide apparently exerted a protective action on the vitamin, while hydrogen had no such action. The analogy is that the carbon dioxide produced by bacteria from readily fermentable carbohydrates can protect vitamins from destruction in the human intestine. The bacteria employed were several strains of the Coli-Aerogenes group and of the Salmonella group, and one each of *Eberthella typhi*, *Bacillus subtilis*, and *Proteus vulgaris*.

Laboratory Service. (Ralph L. France.) Following is a list of the numbers and types of examinations made during the past year:

Milk (bacteria counts)	1,398
Ice Cream (bacteria counts)	89
Water	119
Miscellaneous:	
Sediment (Milk)	16
Mastitis	1
Wash Water	12
Throat Swabs	15
Smears	3
Total	1,653

Bacteriological Study of Machinist Cutting Compound (James E. Fuller.) This survey study was reported in *Journal of Bacteriology* 34 (No. 2):241, 1937.

DEPARTMENT OF BOTANY

A. Vincent Osmun in Charge

Effect of Soil Temperature on Gardenia. (L. H. Jones.) In a series of experiments carried on in the soil temperature tanks, it was determined that a chlorosis of gardenia may be induced at any time of the year by a soil temperature of 18° C. and less and develops more intensely directly as the soil temperature is lowered. The number of days necessary to induce chlorosis varied with the health of the plants at the time the temperature was lowered. Hard plants growing at medium temperatures developed chlorosis more slowly than soft plants grown at high temperatures. A sharp rise in soil temperature maintained for 13 days was sufficient to initiate the return of a healthy green color.

Soil temperature affected growth rates and the final size of the leaf. The rate of growth was inversely correlated with the intensity of the development of chlorosis. The size of the leaf was correlated with soil temperature directly as the soil temperature was increased.

Plants which had been growing at a high soil temperature and were suddenly subjected to a low soil temperature were unable to absorb enough water to maintain turgidity in the leaves. The plants wilted in sunshine but recovered turgidity at night. Recovery was complete in about two weeks.

Lowering the soil temperature to 10° C. or less caused a rapid senescence of the oldest leaves.

There were indications that a low soil temperature altered the vegetative or growing phase to a reproductive or flowering phase.

Soil Temperature as an Important Ecological Factor in Greenhouses. (L. H. Jones.) Investigations indicate that the real value of air temperature control in greenhouses may lie in its effect on soil temperature, for soil temperature has a greater influence on plant development than has air temperature. Knowledge of factors affecting soil temperature would lead to changes in practice that should maintain the desired soil temperature. There is a lag in the rise and fall of soil temperature as the air temperature is maintained high or low, which may be as much as four hours in benches and considerably longer in ground beds, and depends not only on the depth of soil, but also on the amount of moisture in the soil. There are two available instruments for measuring soil temperature. One is a soil thermometer similar to ordinary air thermometers, except that the bulb is protected by a pointed, perforated metal cap which is thrust into the soil. The other is a recording soil thermometer. The first gives the reading only at the time it is observed. The recording type reproduces all values on a chart for the duration of a week. An effort is being made to construct a maximum-minimum thermometer for soil work. Such an instrument will be of greater value than the type which gives no record of changes and will be less expensive than the recording type.

Root-System Development of Hardened Plants. (L. H. Jones.) Potted gardenia and rose plants which had become hardened by lack of nitrogen and frequent drouth conditions were slow to develop new roots and shoots when transplanted to a rich soil that was kept moist. However, when the hardened plants were watered with a dilute solution of ammonium sulfate (one ounce per gallon) five days before transplanting, there was a much greater increase in the number of roots and length of shoot development than when the plants did not have the nitrogen applied before transplanting. The results obtained from these tests indicate that there is an advantage for reestablishment of plants in applying nitrogen before the root system is disturbed.

Study of Diseases of Ornamental Herbaceous Plants Caused by Soil-Infesting Organisms, with Particular Attention to Control Measures. (W. L. Doran.) Work under this project has involved a search for better methods for using old soil disinfectants as well as other chemicals, and for possible new soil disinfectants, which may have more nearly ideal qualities. The soil used was either naturally infested or artificially inoculated with Pythium and Rhizoctonia. *Rhizoctonia solani* Kuhn. used for test purposes during the past season was isolated from *Mentha Requienii* Benth. and *Cerastium tomentosum* L.

Undiluted vinegar, 200 to 235 cc. per sq. ft., has continued to give satisfactory control of damping-off. Worked into or mixed with the soil immediately before seeding, this has usually been safe enough although crucifers seem to be less tolerant of acetic acid (of which vinegar contains about 4.0 percent) than are the other plants used. Crucifers are less tolerant of formaldehyde also and the point is of some importance, for the family includes a number of the most popular ornamental plants: for example, species of Arabis, Cheiranthus, Hesperis, Mathiola, Aubrietia, Draba, Alyssum and Iberis. Treatments especially adapted to them are now being developed.

Other things being equal, the species most subject to injury by acetic acid or formaldehyde, applied to soil immediately before seeding, were those the seeds of which germinate most promptly.

About 8 cc. of acetic acid (80 percent), diluted to 300 cc. (per sq. ft. of soil), did not injure even crucifers when seeds were sown immediately after it was worked into the soil. By the prevention of some pre-emergence damping-off,

this treatment usually improved germination as did also formaldehyde 6 cc. (in 500 cc. water) similarly used.

Formic acid appears to be a good soil fungicide and its use is now being further investigated. Seven cc. of formic acid (90 percent), diluted to 300 cc. (per sq. ft.) and mixed with the soil immediately before seeding, controlled damping-off very well, improved germination of all species with which it was used, and did not interfere with growth. It must, of course, be handled with care to avoid injuring one's skin.

Work with salicylic acid has been continued, for an application of 6 to 8 gm. per sq. ft. has, in the presence of fungi, usually improved germination; and this material, being a crystalline powder, has the advantage of being readily applied to soil without the necessity of first preparing either a dust mixture or a solution.

A pyroligneous acid, made from pine wood, was applied to soil at the rate of about 125 cc. per sq. ft., undiluted, immediately before seeding. This satisfactorily controlled damping-off without injury to the species of plants with which it was used, and its use in this way, without the addition of water, is now being studied further.

Some work has been done on the sterilization of soils, in closed containers, by the vapors of formaldehyde rather than by a solution. Soils so exposed to these vapors, for a few days, could not be used immediately without injury to seeds, but after being aired for two days, there was no injury to growth and, most fungi having apparently been killed, germination was improved.

There are soils in the trade which have been sterilized by the firms supplying them and, unless they later become contaminated, there is little or no damping-off in them. To lessen the cost of using such soil, the writer has diluted it with washed sand, up to half and half. No increase in damping-off resulted; and seedlings, up to that stage at which they are commonly transplanted, grew well without the addition of nutrient.

Damping-off and Growth of Seedlings and Cuttings of Woody Plants as Affected by Soil Treatments and Modifications of Environment. (W. L Doran.) Because of the interest of nurserymen in the effects of such growth substances as indolebutyric acid on rooting of cuttings, a paper on some of the writer's results was published in our Nurseryculture Bulletin vol. 2, no. 5 (September 15, 1937) and work along this line has been continued. Special attention is being given to the time of taking cuttings and the relation of season to the response to treatment.

Such treatments are unnecessary for the cuttings of many species which, if taken at appropriate times, root readily enough without treatment. This was true of the following species when cuttings were taken at the times of year mentioned: *Viburnum rhytidophyllum* Hemsl., *Cephalanthus occidentalis* L., *Buddleia Davidi* Franch., and *Stephanandra incisa* Zabel. in the first week of August; *Pachistima Canbyi* Gray, *Coronilla Emerus* L., *Helianthemum nummularium* L., *Chamaecyparis pisifera* Endl. var. *plumosa* Beiss., *Thuja occidentalis* L. var. *umbraculifera* Beiss., and *Juniperus Sabina* L. var. *tamariscifolia* Ait. in the third week of October; *Cytisus Beanii* Nichols., *C. purgans* Benth. & Hook., *Genista pilosa* L., *Vaccinium Vitis-Idaea* L., and *Calluna vulgaris* (L.) Hull. in the third week of November; and *Juniperus communis* L., *J. procumbens* Sieb., and *J. scopulorum* Sarg. var. *horizontalis* D. Hill in the last week of December.

Some other species and some of the above if taken at other times may root more rapidly if cuttings are treated, but not always in larger percentages finally. This was the effect, for example, of indolebutyric acid on Calluna and *Dorycnium hirsutum* Ser. It may, in fact, be principally by hastening rooting that such treatments improve the rooting of cuttings of some species, for cuttings which

root more rapidly as a result of treatment are less likely to die unrooted than are cuttings which, without treatment, root more slowly. The life of unrooted cuttings is limited and they either root or rot. If they rot, it is partly because they did not root, but if they do not root, it is not necessarily and only because they rot; and such experience as the writer has had with these treatments does not indicate that they are fungicidal.

Species which not only rooted more rapidly, but also in decidedly larger percentages after treatment with indolebutyric acid than without it, when cuttings were taken at these specified times, included: *Passiflora racemosa* Brot. (last of June); *Ilex crenata* Thunb., *I. yunnanensis* Franch., *Cyrilla racemiflora* L., and *Pentstemon Scouleri* Dougl. (first of September); *Stewartia koreana* Nakai, and Franklinia (first of August). Similar treatment with indoleacetic acid (usually 0.10 gm. in 1000 cc. water for 24 hours or 0.05 gm. in 1000 cc. for 48 hours) improved the rooting of cuttings of these species: *Lespedeza formosa* Koehne (middle of October); *Taxus media* Rehd. var. *Hicksii* Rehd., *T. cuspidata* Sieb. & Zucc. var. *densa* Rehd., *Picea pungens* Engelm. var., *Chamaecyparis pisifera* Endl. var. *squarrosa* Beiss. & Hochst., *C. obtusa* Endl., *C. obtusa* Endl. var. *aurea* Beiss. and *C. obtusa* Endl. var. *nana* Carr. (last of December).

The importance of the time of taking the cuttings cannot be overemphasized whether or not cuttings are to be treated. Cuttings of *Picea glauca* Voss. var. *conica* Rehd. rooted better when taken in December than when taken in October and those taken in December were more benefited by these treatments.

Cuttings of many species, taken when they were, rooted equally poorly with and without treatments, there being no apparent benefit to the varieties of Norway spruce, for instance, when taken in December, or to several species of Rhododendron taken in November and December. This was true also of *Cotoneaster horizontalis* Decne., with cuttings taken the first of October, although cuttings of this species rooted well, even without treatment, if taken by the middle of June. Franklinia, similarly, rooted very poorly, with or without treatment, if cuttings were taken early in September, although their rooting was improved by indolebutyric acid when they were taken a month earlier. Generally speaking, and with some exceptions, cuttings of harder wood were less benefited by these treatments than were cuttings of the same species taken a little earlier.

If treatment with indolebutyric acid was ineffective, so, in most cases, was treatment with indoleacetic acid. Rooting of cuttings of *Genista pilosa* L. and of *Taxus cuspidata* Sieb. & Zucc. var. *Thayerae* was, however, benefited more by indoleacetic than by indolebutyric acid.

Although most cuttings were treated immediately before insertion, those of a few species were inserted without treatment, removed and treated two weeks later, and then reinserted. This was done with the thought that such a delayed treatment, if effective, may be useful in the case of cuttings which are not rooting as they should or which, for any reason, were not treated before the original insertion. Such treatment (with indoleacetic acid) improved the rooting of cuttings of Japan quince and of *Enkianthus subsessilis* Mak., but was of no value in the case of cuttings which had begun to decay before treatment, as had those of *Lonicera alpigena* L., and was slightly injurious to cuttings of buttonbush which had already begun to develop roots.

Treatment with formic acid (0.2 or 0.4 gm. in 1000 cc. for 24 hours) improved the rooting of cuttings of *Viburnum dilatatum* Thunb., *Ilex crenata* Thunb., and *Hypericum* sp. The use of this chemical is now being further investigated, for the writer has found that, in greater concentrations, it has fungicidal properties and it is less expensive than the chemicals above mentioned.

With a view to preventing infection of cuttings in sand-peat moss inoculated

with Pythium and Rhizoctonia, basal ends of some cuttings were dipped (dry) in zinc oxide powder. This proved to be very injurious to cuttings of all species with which it was used.

Copper carbonate, 5.5 gm. per sq. ft., mixed with this medium before the insertion of cuttings, was no less harmful, the only species not much injured by it being two barberries, *Berberis Julianae* Schneid. and *B. stenophylla* Lindl.

Acetic acid does not remain in the soil long enough to protect against damping-off the seeds and seedlings of species which germinate slowly. Copper oxalate, 6 gm. per sq. ft., applied to soil before seeding, gave much better results with *Sciadopitys verticillata* Sieb. & Zucc., seeds of which germinated 3 months after seeding.

Chemical Soil Surface Treatments in Hotbeds for Controlling Damping-Off of Early Forcing Vegetables. (W. L. Doran with E. F. Guba.) A soil disinfectant may be applied to the soil (1) before seeding, (2) after seeding, but before germination, or (3) after the emergence of seedlings. The first of these methods has been most common in the past, but there is a continued demand for more convenient methods and these may include treatments to be applied later.

The writers have found no treatment effective against damping-off which at the same time is safe to use after the emergence of seedlings, which means with living plants. Vinegar, in amount too small to protect against damping-off, was injurious to seedlings of most species even when variously diluted.

Such a treatment could not improve germination anyway; and more attention has therefore been given to the application of a soil disinfectant immediately after seeding and before germination.

The important point is not so much when as how a chemical is applied to soil, there being often no more than ten minutes' difference between the times of application of treatments before and after seeding. It should be further understood in this connection that a chemical applied to soil after seeding cannot, because of the earlier presence of the seed, be worked into or mixed with the soil and that it is, therefore, more concentrated near the soil surface and, consequently, near the seeds.

That being the case, the possibility of injury to the seeds is greater and applications which were safe enough if applied to soil immediately before seeding were injurious in some cases if applied immediately after seeding. Thus as little as 4 cc. formic acid (90 percent) diluted to 250 cc. (per sq. ft.) was harmful if applied to soil immediately after seeding, although 7 cc. applied before seeding was not injurious to the same species. Formaldehyde 7 cc. and acetic acid (80 percent) 8 cc. per sq. ft., or either one of these diluted with 5 times those volumes of water and applied to soil immediately after seeding, was injurious to species to which they were quite harmless if mixed with soil before seeding.

Treatments applied after seeding were generally least injurious to species the seeds of which germinate relatively slowly, as do those of pepper, and more injurious to seeds, such as cabbage, which germinate in fewer days or before enough of the volatile chemical has escaped from the soil.

When formaldehyde is diluted 1:300 and applied to soil at the rate of 0.75 qt. per sq. ft., there is only about 2.3 cc. formaldehyde per sq. ft.; but even this light application, when made immediately after seeding, prevented most early damping-off. It did not injure tomato, eggplant, pepper or lettuce, but it did injure cress, the only crucifer with which it was used. It was not proved that such a light application would be for long effective in preventing fungi from growing up from the soil below, but such methods are convenient, if sufficiently effective, and they are being further investigated.

Vinegar 175 cc. (per sq. ft.) diluted with an equal volume of water and applied

after seeding, was harmful to cabbage; but 220 cc. similarly used did not injure pepper or several species of Opuntia, the seeds of which, like those of pepper, germinate relatively slowly. This amount of vinegar, 220 cc., prevented most damping-off, but more than 200 cc. is not ordinarily to be used in this way with safety to most species. The use of vinegar after seeding appears to be feasible and details of method and dosage are now being further developed.

Pyroligneous acid is being similarly used experimentally and with encouraging results

Different chemical powders were dusted on lettuce and cabbage seedbeds in flats after firming the soil over the seed, and again upon emergence. On lettuce, the stand was improved over the check 11 percent with red copper oxide, 5 percent with Basi-Cop, 1.6 percent with Vasco, 6 percent with calomel, and 2 percent with a 20-80 monohydrated copper-lime dust. On cabbage, the stand was improved 18 percent with Vasco, 10 percent with zinc oxide, and 15 percent with a 20-80 copper-lime dust.

Control of Greenhouse Vegetable Diseases. (E. F. Guba, Waltham.) Since the previous report, the tomato resistant to Cladosporium leaf mold has been crossed back to the Waltham Forcing tomato for increase in size. Two generations of these crosses have been grown and selected for resistance and quality. The resistance of these tomatoes has been confirmed by other investigators in the United States and other countries. Their reports would indicate the occurrence of but one strain of the fungus.

Carnation Blight caused by Alternaria dianthi S. & H. (E. F. Guba, Waltham.) The relation of the newer varieties of carnations to blight was studied at Waltham, and 72 distinct varieties of carnation were grown at the Jahn greenhouses at East Bridgewater to observe their reaction to branch rot caused by *Fusarium dianthi*, a serious parallel problem, in anticipation of the preparation of a performance chart of the behavior of varieties to both *Alternaria dianthi* and *Fusarium dianthi*. All the Boston Ward types are very susceptible to both organisms, but their superior quality otherwise may justify efforts at breeding for disease resistance.

Causes and Control of Decay of Winter Squash in Storage. (E. F. Guba and C. J. Gilgut, Waltham.) Comparative studies were made of storage conditions, amount of squash decay, and loss from shrinkage. The squashes used in these studies were all from the same field. In a heated storage with the temperature averaging 57.3° F. and the relative humidity 62.0 percent, there were 21.3 percent infected or decayed squashes and the shrinkage in weight was 9.2 percent. In two other storages heat was employed only to avoid freezing. In one of these with the average temperature and humidity respectively 44.4° and 72.4 percent, decay and shrinkage were respectively 4.1 and 9.4 percent; while in another with average temperature and humidity at 44.4° and 83.9 percent, decay and shrinkage were respectively 14.3 and 7.3 percent.

Miscellaneous Tests and Experiments. (E. F. Guba and C. J. Gilgut, Waltham.)

1. *Control of the Begonia Leaf Nematode* (*Aphelenchoides fragariae*). All stages of the nematode in the leaves are killed in water of a mean temperature of 115° F. (5 minutes), 117½° F. (3 minutes), 118½° F. (2 minutes), and 120½°F. (1 minute). Submersion of plants in water at temperatures of 121-120° F. for 1 minute, 119-117° F. for 2 minutes, or 118-115° F. for 3 minutes, is recommended for infested stock, and the eradicative treatment should be made not nearer than

3 months to the marketing season. The same interval-temperatures proved safe for leaf cuttings. Sanitary and cultural methods within the limits of good plant growth and commercial practice are not effective in arresting the progress of the disease.

2. *Apple Scab Control.* Five brands of wettable sulfur of different sulfur content ranging from 30 to 98½ percent, and varying in particle size from 0.9-6.3 microns to 3-4.5 microns with different brands, were compared on an equivalent sulfur basis in a full schedule of treatments with the official spray schedule of liquid lime-sulfur and wettable sulfur for scab control and foliage tolerance. The coarsest and finest wettable sulfurs gave the poorest and best control, respectively. Injury to the foliage, which was severe, occurred only from liquid lime-sulfur. The materials and results are tabulated as follows:

Material	Sulfur Content Percent	Dilution Pounds in 100 Gallons	Scabby Apples Percent	Average Number of Infections per Scabbed Apple
Linco	55	3.2	No apples	No apples
Hood	98.5	1.8	13.3	3.3
Magnetic	98.5	1.8	23.8	3.3
Flotation	40	4.5	2.5	1.0
Kolofog	30	6.0	8.3	5.0
Official schedule			0.0	0.0

3. *Vegetable Seed Treatments.* Soaking of celery seed in corrosive sublimate solution (1-1000) for 20 minutes, usually recommended as a disease control measure, was found in a series of tests to be definitely harmful to the seed. The mean stand of plants was reduced approximately one half by the treatment.

A test of different chemical treatments of vegetable seeds for damping-off control was conducted and the results embodied with the data of previous years. The preferred seed treatments for controlling damping-off, based on these tests, are indicated as follows:

Red Copper Oxide	Semesan	Zinc Oxide
Beet	Bean (snap)	Bean (lima)
Carrot	Cabbage	Parsnip
Cucumber	Cauliflower	Radish
Eggplant	Corn	Turnip
Lettuce	Onion	
Muskmelon	Pea	
Pepper		
Spinach		
Squash		
Tomato		

4. *Resistance of Cucumbers to Powdery Mildew* (*Erysiphe cichoracearum* DC.). This disease is a major problem in the culture of greenhouse cucumbers. A test in cooperation with Prof. R. E. Young in search of resistance among 169 types of cucurbits, mostly cucumbers, supplied by the Division of Plant Exploration and Introduction, United States Department of Agriculture, showed a high degree of susceptibility by all except *Cucumis Melo* L. var. *flexuosus* Naudin, the snake melon, which was resistant but which does not cross with the cucumber. Studies will be made of other types.

5. *Copper Spray Tests on Cucumbers, Muskmelons and Tomatoes.* These crops were used to test the merits of newer copper fungicides. This year Copper Hydro 40, Coposil, Dow Copper Fungicide, Basi-Cop, Cupro-K, Cuprocide 54,

Copper Zeolite, Copper Oxychloride A, and Bordeaux 4-4-50 were compared on the basis of copper content. In the absence of much disease, yield was best without any treatment with cucumbers and tomatoes, while Basi-Cop ranked first with melons. On cucumbers, Cuprocide 54, Bordeaux 4-4-50, and Cupro-K showed the poorest in appearance and yield; on melons, appearance was noticeably inferior only with Bordeaux, while the yields were poorest with Copper Oxychloride, Bordeaux 4-4-50, and Cuprocide 54. With tomatoes, the yields were poorest with Coposil, Copper Zeolite, and Burgundy Mixture, and this was not associated with any greater amounts of early blight.

Diseases of Trees in Massachusetts. (M. A. McKenzie and A. Vincent Osmun.) Investigations of the diseases of shade and ornamental trees in Massachusetts, begun in the summer of 1935 and continued throughout 1936, were carried on during the past year. Field and laboratory studies centered around the diseases of elm.

In a recent elm census report, the value estimated for the elms in four Massachusetts cities and towns was conservatively placed at $7,300,000. However, in the final analysis, all fiduciary ratings fail in an actual evaluation of elms in New England. Indeed to no small degree, the elms may be said to identify New England, and Massachusetts occupies an important place in this arboricultural identification. Any threat to the elm in this State, therefore, is cause for alarm, and since 1930, when the Dutch elm disease was first discovered in America, all persons interested in our principal shade tree have become increasingly concerned as the number of elms known to be affected by this disease has steadily mounted. Up to the present writing (December 1937), the disease has not been found in Massachusetts. Nevertheless, an important part of the work on tree diseases covered by this report has been the preparation of a bulletin[1] containing basic information concerning the characteristics and spread of the Dutch elm disease.

It is to be hoped that if the public is adequately informed on the disease, the chances of early report and prompt diagnosis of trees suspected of infestation will be conspicuously favored. Since no adequate treatment is known for affected trees, their prompt removal is imperative in any attempt to control the disease. Such a program is in operation in states where the disease has been discovered and at present, as far as is known, the number of affected elms left standing is almost negligible. The hopeful opinion that control of the disease is not impossible has been expressed by persons charged with the responsibility of the eradication program in the infested areas. However, the privilege of this statement entails the responsibility of constant vigilance, and in actuality control is a corollary to patrol. Any encouragement in the present favorable outlook is justifiable only as long as constantly changing conditions are studied and recorded.

It would be extremely difficult if not impossible to designate a single feature of the control program in infested areas as the one responsible for its apparent current success, and no attempt will be made to do so. One principal result of the program in uninfested areas like Massachusetts, as well as in areas where the disease is present is profoundly evident: a demand on the part of the public for information and work programs for general tree improvement. Sustained and increasing public interest in tree problems is apparent by the number of inquiries on these matters received from the citizens of Massachusetts. The adoption of a program for the promotion of the health of the tree population comparable to the public health programs for the human population has resulted in many communities throughout the State. Many tree diseases, in particular the Dutch elm disease,

[1]Published as Mass. Agr. Exp. Sta. Bull. 343, May 1937.

may be identified only by laboratory diagnosis. Since the establishment of the Shade Tree Laboratory in June 1935, approximately 5700 specimens have been received for diagnosis. During 1937, laboratory studies of more than 700 specimens, including collections by 4 field men, were completed by cultural and microscopical methods. Sixty-six diseases of 32 hosts, including 12 diseases of elm, were studied during the year.

Experiments, initiated in 1936, on potted elms of several species inoculated with fungus parasites of elm known to be present in Massachusetts have been continued in the greenhouse during the past year.

A detailed study[2] of the State-wide distribution of elm wilts associated with Cephalosporium and Verticillium was completed by Miss Eunice M. Johnson, Institutional Fellow in Botany.

Cytospora Disease of Spruce. (C. J. Gilgut, Waltham.) Experiments for the control of this disease have been inaugurated with diseased trees of Colorado blue spruce on a private estate in Holyoke and a cemetery in Worcester. The appearance of the trees has been much improved by removal of diseased and dead limbs, and in Holyoke by a summer application of an inorganic fertilizer. The trees in both locations are to be fertilized and sprayed in the spring of 1938.

DEPARTMENT OF CHEMISTRY

W. S. Ritchie in Charge

Cooperative Analytical Service. (The Department.) Service to outside departments and individuals has been continued. Samples of milk from Harvard Medical School were analyzed for traces of copper with the view of evaluating methods. Thirteen samples of so-called "foreign breads" collected in Boston in connection with the work on diabetes of the Boston City Hospital were analyzed for total carbohydrate. In addition the proximate analysis was determined. The results of the analysis of these breads are expected to be published in a short time.

Cooperation has continued with the workers at the Waltham Field Station. In particular, certain paint samples (about 18 in number) have been analyzed for soluble zinc and sulfur salts in connection with the "burning" of plants following fumigating with sulfur. Details of this work appear in the reports of that group.

Testing Analytical Methods. (The Department.) The methods for determining iron, copper and manganese, previously reported, have received continued study to the end that they may be made simpler, more accurate, and more rapid.

Acting as associate referee for methods of determining zinc in small quantities, a method was developed and reported to the Referee on Metals in Foods. By this method the ashed sample is dissolved in 2N hydrochloric acid, since the wet combustion method (sulfuric and nitric acids) was found to be unsuitable. To this acid solution, the carbamate reagent (sodium diethyl dithiocarbamate) and the dithizone (diphenyl thiocarbazone) are added in excess and shaken with carbon tetrachloride. The latter was found to be more agreeable to use than either chloroform or amyl alcohol, solvents sometimes used in this connection. The organic solvent containing some of the interfering metals is discarded and the aqueous solution of the zinc is treated with ammonium citrate, ammonium hydroxide, the carbamate reagent and an excess of dithizone. This is again shaken with carbon tetrachloride, which is washed with dilute (0.02M) ammonium

[2]Published in Plant Disease Reporter 21:3:58-59. Feb. 15, 1937.

hydroxide, and then compared to a standard prepared in the same manner. Such a method shows practically a complete recovery between 5 and 25 gammas of zinc. For larger amounts of zinc, the use of suitable aliquots of the sample was recommended rather than the development of a different procedure. Details of the method will appear in the Journal of the A.O.A.C.

Methods for the determination of boron are now under consideration since it is becoming more and more evident that this element is a factor to be considered in certain crops, and methods for measuring small amounts are necessary.

Vitamin C (ascorbic acid) may be determined satisfactorily in comparison with the bio-assay by titration with a dye, 2, 6-dichlorophenolindophenol. The dye has usually been standardized against either pure ascorbic acid or lemon juice. A new method has been devised for the standardization of the dye, agreeing very well with the two methods above, based on the quantitative oxidation of iodide to iodine. The iodine liberated is titrated with standard sodium-thiosulfate. This method is much simpler, involving only one titration, once the standard solution of sodium-thiosulfate is prepared. This method was presented and discussed at the recent meeting of the American Chemical Society at Rochester, New York, and will appear, in abstract, in the journals of that organization.

The Iron, Copper, Manganese, and Iodine Content of Fruits and Vegetables Used as Human Foods. (E. B. Holland, C. P. Jones, and W. S. Ritchie.) This project, having for its objective an analytical survey of common foods, including grains, fruits, vegetables, nuts, etc., has been continued. Sixty-two new samples have been collected and prepared for the analysis which is under way. The proximate analysis is being determined as well as the content of iron, manganese, copper, iodine, phosphorus, and zinc.

With the cooperation of the workers at the Waltham Field Station, it has been possible to get samples of vegetables including celery, beets, carrots, cabbage, and spinach, whose history is known, i.e., the soil type producing them, fertilizer treatment, irrigation, and other cultural practices. It is expected that such samples will reflect the influence of these treatments assuming that there is an effect.

Approximate Range in Some Ash Constituents
In Terms of Dry Matter

	Crude Ash		Iron	Copper	Manganese	Phosphorus
	Acid Soluble %	Acid Insoluble %	ppm	ppm	ppm	ppm
Major fruits	1– 3.5	0.00–0.03	10– 80	5–15	tr.– 10	200– 1800
Berries	1– 5	0.00–0.25	40– 180	5–40	20–170	600– 2900
"Garden" fruits	4–11	0.00–0.15	20– 130	5–40	tr.– 35	1200– 5000
Leaf and stem vegetables	9–23	0.02–2+	25–1000	5–35	tr.–250	3000–10000
Root vegetables	4–15	0.02–0.10	20– 200	5–40	tr.– 35	1400– 5000
Cereals[1]	1– 3	0.00–0.50	30– 120	5–15	tr.– 60	900– 4500
Nuts	2– 4	0.00–0.01	tr.– 150	5–25	10– 45	2500– 7500
Peas and beans	4– 8	0.00–0.10	75– 100	5–25	10– 35	4500– 7000

[1]Excluding unhulled grains.

The completion of the analyses of the samples now in the process should, with a few additional ones, finish this survey.

Absorption by Food Plants of Chemical Elements of Importance in Human Physiology and Nutrition. (E. B. Holland, W. S. Ritchie, and W. S. Eisenmenger.) Work on this project was confined to an association with the investigators at the Waltham Field Station. Tomatoes and lettuce were grown in the greenhouses rather than in the open and were fertilized with compounds of iron, manganese, copper, and iodine. In the case of the tomatoes both the vines and the fruits were saved. Growing the vegetables under glass has the advantage that the samples are cleaner and freer from soil than when grown in the open. Since the analyses are dealing with minute quantities of the elements, freedom from soil particles is important. The samples thus obtained were added to that group being analyzed in the previous project.

The Carbohydrates in Kentucky Bluegrass. (Emmett Bennett.) The procedure and outstanding results of previous years have been given in the Annual Reports of 1935-36. Data obtained in 1937 indicate that the content of structural carbohydrates increases with maturity and that these values are greater in the morning than at night; that the content of sucrose decreases with maturity but is greater at night than in the morning. Results of this investigation will soon be ready for publication.

Hemicelluloses of Tobacco Stalks. (Emmett Bennett.) A polyuronide hemicellulose from the cured stripped stalks of Havana seed tobacco has been isolated and studied. Upon hydrolysis the polyuronide yields xylose as the chief sugar. Details of this study have been published in *Industrial and Engineering Chemistry* (*Industrial Edition*) 29: 933, 1937.

Bacteriostatic Effect of Lignin. (Emmett Bennett.) Because of the bacteriostatic effect isolated lignin has been known to exert on decomposing plant material, it was believed that the intestinal flora of the rat might be changed by the ingestion of a diet high in lignin. Thus far results obtained in feeding a small number of rats do not indicate a definite change in the intestinal flora. Limited data, however, indicate that the ingestion of a high lignin diet by the rat is accompanied by losses in carbohydrate and nitrogen fractions. The lignin ingested may be recovered almost within limits of experimental error. The experiment is to be repeated with a larger group of animals during the coming year.

The Vitamin A Content of Pasture Grasses. (W. S. Ritchie and J. G. Archibald. Cooperative with Animal Husbandry.) In 1936 the vitamin A content was determined in samples of sheep fescue, Rhode Island bent, bluegrass, red top and timothy. The work of 1937 continued the assays for the vitamin A content of these grasses from both fertilized and unfertilized plots. Duplicate samples were available from these plots during the early growing season (June) and during the later period of growth (August). Samples of orchard grass and sweet vernal were added to the five reported on in 1936.

The data indicate that, generally speaking, the vitamin A content is higher in the grasses from the fertilized plots than from the unfertilized. The seasonal variation does not seem to be as great as that attributed to the application of commercial fertilizers.

Chemical Changes in the Cooking of Vegetables. (Monroe E. Freeman and W. S. Ritchie.) Chemical factors contributing to texture rating of cooked potatoes were investigated in two mealy and two waxy varieties. (These terms are used here according to definitions outlined in Maine Agricultural Experiment Station Bulletin 383, p. 344.) The four samples were obtained, in part, on the open market and came from different localities. The same varieties have since

been grown in one plot during the summer of 1937. The data reported here were drawn only from the first four samples, and the tentative conclusions may necessarily be modified when the complete data are assembled.

Starch and dry matter were found to be closely correlated with texture after storage periods of three months and five months. This relationship was not evident from samples analyzed before the storage periods.

Previous workers have been unable to relate pectin fractions with texture of cooked potatoes. It has been found that the usual methods of pectin analysis and fractionation, originally devised for other types of plant material, could not be applied to potato without modification. Modified methods were devised that eliminated the protein and starch contaminants. These methods demonstrated that all potato samples tested — raw, baked, and steamed — contained very nearly 2 percent total pectin regardless of variety or texture. A fraction usually designated as calcium pectate ranged from 0.2 percent to 0.5 percent, with no apparent relation to texture or variety. The so-called "proto pectin" (acid soluble) could be completely extracted from potatoes in 12 hours by water at 85° C.

Additional data suggest that the larger part of the pectin in potato is so loosely bound that it is hardly comparable to the "proto pectin" fraction in other types of plant material. The total amount of this fraction, however, is not related to texture. While small amounts of pectin can be obtained by exhaustively extracting (mortar and pestle) fresh tissue with cold water, no pectin was extracted from dried, finely ground samples by water at 37° C.

Preliminary results indicated that the so-called "proto pectin" fraction was more loosely bound in mealy potatoes than in waxy varieties. This allowed a means of relating pectin to texture. Under certain conditions mealy varieties, cooked and raw, gave two to three times as much pectin as waxy varieties.

The usual method for drying potato samples did not increase the amount of soluble pectin through enzyme hydrolysis. On the other hand, a boiling ethanol dip, used presumably to halt this enzymatic hydrolysis, actually rendered water soluble (37° C.) 20 percent of the total pectin.

Cooking increased the water soluble (37° C.) pectin fraction from 0 percent to 70 percent of the total pectin. Starch (including dextrin) decreased to some extent. Reducing sugars increased slightly on cooking. Other data have been obtained, and experiments are in progress concerning the effect of storage on these and other relationships.

Possible changes in the potatoes due either to storage or to cooking or both are also being followed by the "in vitro" methods suggested by Horwitt, Cowgill, and Mendel. These methods were first used and reported on leafy material (spinach). It is likely that some modification of the method will be necessary since with potatoes (a starchy product) the crude fiber as determined is practically the equivalent of the total carbohydrate. Using the method with such a sample as spinach, the carbohydrate (starch, etc.) would apparently be included as part of the crude fiber.

In addition to the work on the potato, possible changes in peas as a result of storage and cooking are being studied. For this purpose samples were obtained from the Birds Eye Frosted Foods Corporation during the past summer. The control sample represented the fresh peas in the pod. These were shipped to the laboratory where they were shelled and dried under suitable conditions. Samples from the same field were canned and frozen and stored under these conditions. These are being withdrawn from storage at definite intervals and prepared for analysis. Comparisons are to be made on the basis of the "in vitro" analysis mentioned above. Complete data are not available since storage periods are not yet finished.

Physical and Chemical Properties of Mosaic Viruses. (Monroe E. Freeman.) Eleven specimens of virus-infected tomato plants collected in commercial greenhouses in Massachusetts were examined. Ordinary tobacco mosaic virus was the only agent identified. Although abnormal symptoms were noted in some test plants, other agents were not found.

Connecticut Broadleaf tobacco seedlings were found to be the most successful test plants for the potato vein banding virus. Other varieties and strains of tobacco developed the typical symptoms more slowly and in many cases the symptoms were not distinct. No test plants could be found for this virus that would produce local lesions suitable for semi-quantitative assay. Plant juices containing this virus clarified by freezing, filtering, or low-speed centrifuging lost to a large extent their ability to infect tobacco seedlings. The evidence seems to suggest that most of the virus is associated with the chloroplasts or the heavier particles of the cellular debris. Experiments on this phase and on the effect of various chemical reagents are in progress.

The Effect of Storage and Processing on the Carbohydrates of Some Varieties of Edible Onions. (Emmett Bennett.) The project was created for the purpose of characterizing the carbohydrates of the onion and ascertaining the changes in this group which have been effected by prevailing storage conditions and by cooking.

Samples of U. S. No. 1 onions, grown from both seed and sets under similar conditions, were obtained from the Frank D. Hubbard Farms, Sunderland, Massachusetts. Representative samples of both types have been stored under varied conditions. To date, December 16, 1937, practically all of the onions grown from seed have sprouted regardless of storage conditions. Raw and cooked onions of both types have been prepared for analysis. Analytical data will not be available until after the storage period.

Lignin and Its Relation to the Absorption of Minerals by Plants. (Emmett Bennett.) This project is intended to reveal more of the chemical nature of lignin and to ascertain to a better degree the functions, if any, of the lignin in the soil with respect to plant nutrition. Lignin for this purpose has been isolated from corn cob and purified. Data are not yet available because of the short time this project has been in progress.

The Nutritive Value of Rare Elements in Plant Nutrition. The Comparative Nutritive Effects of Copper, Zinc, Chromium, and Molybdenum. (H. R. DeRose, W. S. Eisenmenger, and W. S. Ritchie.) The report of work on this project is given in the report of the Department of Agronomy.

Changes in Frozen Meat During Storage. (W. S. Ritchie.) This project had for its objective the determination of the changes, chemical and physical, occurring in meat during storage at freezing temperatures.

Samples for the work now in progress originated at Purdue University as the result of a feeding trial with hogs. The hogs were slaughtered and processed by Kingan and Company of Indianapolis and frozen by the Birds Eye Frosted Foods Corporation of Boston. Samples were furnished immediately on the killing of the hogs and again after freezing for a week or ten days. Subsequent samples from the same group of animals will appear at intervals of three, six, nine and twelve months. The work in progress includes the determination of the vitamin B and G content of the meat, the biological and growth-promoting value of its protein, tenderness, and nitrogen fractions as well as the usual analysis for total protein, fat, ash, and water.

The Nutritive Value of Chocolate Milks. (William Mueller and W. S. Ritchie.) (Dairy Department cooperative with Experiment Station Chemistry.) The details of this project will be found in the reports of the Dairy Department.

THE CRANBERRY STATION
East Wareham, Massachusetts

H. J. Franklin in Charge

Injurious and Beneficial Insects Affecting the Cranberry. (H. J. Franklin.)

Grape Anomala (*Anomala errans* Fab.). Early in May, 1937, two to three acres of the Santuit bog of the Smith-Hammond Co. in Mashpee were found to be infested seriously with grubs of this insect. Beetles were reared from some of these grubs in June. Many grapevines were growing near the infested bog. This is the third bog that has been found badly affected by this pest during the last few years.[1] As the species completes its life cycle in a year, the grubs of an infestation do not vary much in size. They look much like those of the cranberry white grub (*Phyllophaga*), but the hind part of the abdomen does not appear dark, because of its contents, as does that of the grub of that species.

Cranberry Weevil (*Anthonomus*). Clear, very high-grade pyrethrum dust (made from flowers grown in Kenia), applied on a warm day early in June at the rate of 100 pounds an acre, gave a good kill, thus confirming the results obtained with this material the year before.[2]

A spray of 15 pounds of derris powder (4 percent rotenone) and one half pound of Areskap in 100 gallons of water, used at the rate of 400 gallons an acre on August 3, failed to give a good kill.

Fire Beetle (*Cryptocephalus incertus* Oliv.). This beetle infested severely and extensively four different bogs — one in Carlisle, one in Lakeville, one in East Middleboro, and one in East Wareham — during the season, thus being far more troublesome than ever before. All but one of the bogs so far known to have been much infested with it have been flooded during the winter but not flowed in June. It has been found attacking severely the foliage of the Howes, Holliston, Bugle, and Aviator varieties, but does not infest Early Black vines much even where they grow close to other vines badly infested. The beetles feed much more on the upper surface than on the under side of the cranberry leaves and more near the margins than toward the middle of the leaf surface. They also excavate or eat around some of the new terminal buds of the vines and so directly reduce the crop of the following year somewhat. They feed much more in August and early September than later, when they are less active because of the lower temperatures. They were also abundant in places on the foliage of the swamp blueberry,[3] black huckleberry,[4] and beach plum.[5]

Clear, high-grade pyrethrum dust (0.9 percent pyrethrin content), applied to an infested bog at the rate of 100 pounds an acre in the middle of a warm day (Sept. 4, 1937) when the beetles were very active, killed less than half of them. A spray of 2 pounds of lead arsenate in 100 gallons of water, applied at the rate of

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[1] Mass. Agr. Expt. Sta. Bul. 339, p. 36, 1937.
[2] Mass. Agr. Expt. Sta. Bul. 339, p. 37, 1937.
[3] *Vaccinium corymbosum* L.
[4] *Gaylussacia baccata* C. Koch.
[5] *Prunus maritima* Wang.

250 gallons an acre, killed nearly all the beetles. This poison should be applied before the middle of August so that it will not remain in too great quantity as a residue on the berries when they are picked.

One grower treated a bad infestation of this insect on August 30, using 6 pounds of lead arsenate in 100 gallons of water and applying 250 gallons to the acre. Some heavy rains fell on the treated area during September, two of them lasting all day. The berries were picked Oct. 2 and many of them showed spray residue then. What seemed to be a sample with about the maximum amount of residue was analyzed by the Fertilizer and Feed Control Division of the station at Amherst with the following results:

.0255 grains of lead per pound of fruit
.01606 grains of arsenic trioxide per pound of fruit

A similar sample analyzed by Arthur D. Little, Inc., showed .006 grains of arsenic trioxide per pound. Another sample, left unpicked until the bog had been flooded for five days after the general picking was done, was found by Arthur D. Little, Inc., to show only .001 grains of arsenic trioxide per pound. It seems from this that several days flooding will do much to remove an arsenical residue from cranberries.

As the experiment station analysis showed both lead and arsenic residue substantially above legal tolerance, special apparatus was devised and 700 barrels of Howes berries were washed with a 2 percent solution of hydrochloric acid and then thoroughly rinsed. They were then dried at the drying plant of the A. D. Makepeace Co. and stored in a screenhouse from two weeks to a month. They kept well and were finally marketed successfully as fresh fruit.

Cranberry Fruitworm (*Mineola*). A spray of 8 pounds of derris powder (4 percent rotenone) and 2 pounds of soap in 100 gallons of water, applied at the rate of 400 gallons an acre on July 10 and again on July 20, controlled this pest almost completely on a bog where the worms took 40 percent of the crop on untreated check areas.

Ten pounds of cube powder (4 percent rotenone) and 2 pounds of soap in 100 gallons of water, applied at the rate of 400 gallons an acre, also gave good control.

Goulac, Ultrawet, calcium caseinate, SS-3, Ortho liquid spreader, coconut-oil soap, and resin fish-oil soap were tried as spreaders for the derris and cube sprays, the soaps giving the best results.

It seems that with either derris or cube powder, two sprays are advisable for control of the fruitworm, one to be applied when all but about a quarter of the bloom is past and the other about ten days later. Small sample lots of the berries should be examined before a bog is sprayed to determine the abundance and condition of the fruitworm eggs present.

Impregnated Pyrethrum Dust. The pyrethrum dust generally used by cranberry growers is the flower heads of the pyrethrum plant ground fine. It is thought that only the pyrethrins on the surfaces of the particles of this dust are effective against insects and that much more of these toxic principles is locked up in the interior of the particles where they cannot function. Pursuant to this reasoning, some manufacturers have prepared so-called impregnated or activated pyrethrum dusts in which the pyrethrins are placed on or brought to the surface of the particles. These dusts contain a considerably smaller percentage of pyrethrins than is present in high-grade pyrethrum dust obtained by grinding the flower heads, and so can be sold for less. Considerable attention was given to testing these dusts in comparison with high-grade pyrethrum dust as controls for gypsy moth caterpillars and blunt-nosed leafhoppers (*Ophiola*). As a general result of

these tests, it may be said that the impregnated dusts, properly prepared and applied, can probably be relied on to check these pests as effectively as the high-grade pyrethrum dust (0.9 percent pyrethrin content), with a material saving in cost. Those who buy these dusts, however, should realize that they are putting themselves more fully in the hands of the manufacturers than they have been in buying the dust used heretofore.

Prevalence of Cranberry Pests. Notes on the relative general abundance of pests on Cape Cod cranberry bogs in the season of 1937 follow:

1. Black-headed fireworm (*Rhopobota*) considerably less prevalent than usual.
2. Fruitworm (*Mineola*) much less abundant than usual, doing probably as little harm as in any season during the last 33 years and finishing its work very early.
3. Weevils (*Anthonomus*) more prevalent than usual, especially on the outer part of the Cape.
4. Fire Beetle (*Cryptocephalus*). See above.
5. Gypsy moth even more destructive in Plymouth County than in 1936, but less so in Barnstable County than in recent years.
6. Tipworm (*Dasyneura*) considerably more prevalent than usual.

Control of Cranberry Bog Weeds. (Chester E. Cross.) This investigation was carried on in 1935 and 1936 by Dr. William H. Sawyer. In 1937 nearly 800 different weed plots were given various treatments with chemicals. Ammonium sulfate, copper sulfate, iron sulfate, kerosene, kerosene emulsions, sodium arsenate, sodium arsenite, sodium chlorate, sodium chloride, and sodium nitrate were tested variously as weed killers. The following were the more important results of this work:

1. A spray of half a pound of sodium arsenite in 100 gallons of water, applied after mid-July, burns all the foliage and more tender stems of the chokeberry[6] and does not injure cranberry vines or berries.

2. A spray of 20 pounds of copper sulfate in 100 gallons of water, applied heavily late in July or early in August, destroys nut grass[7] very effectively. At the same time of year, a stronger solution, 25 pounds in 100 gallons, burns off the tops of *Bidens* and *Aster* and the foliage of wild rose and severely burns barnyard grass[8] and some kinds of *Panicum* and so keeps them from seeding. It is also considerably effective against loosestrife.[9] These sprays do little or no harm to cranberry vines or fruit. Copper sulfate is evidently a very important addition to the list of chemical killers of cranberry bog weeds. It kills some of the same weeds that kerosene kills and at half the cost for materials.

3. A spray of 1½ pounds of sodium arsenate in 100 gallons of water, applied early in August at a rate of 100 to 150 gallons an acre, is a satisfactory treatment for wild bean,[10] triple-awned grass,[11] and partridge pea.[12] It also burns off the foliage of the coarser brambles.[13]

4. A paddle-mix emulsion of kerosene and water, made with Aresklene or Nopco fish-oil soap as the emulsifier, promises to control horsetail[14] as well as

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6 *Pyrus melanocarpa* Willd.
7 *Cyperus dentatus* Torr. and *C. strigosus* L.
8 *Echinochloa.*
9 *Lysimachia terrestris* B S P.
10 *Apios tuberosa* Moench.
11 *Aristida gracilis* Ell.
12 *Cassia Chamaecrista* L.
13 *Rubus* spp.
14 *Equisetum* spp.

kerosene alone, at a third of the cost for materials. It also burns off completely the foliage of hoary alder.[15]

5. A spray of 75 pounds of sodium chloride in 100 gallons of water eliminates fireweed[16] and beggar-ticks.[17]

6. Iron sulfate spread broadcast late in June or very early in July, a ton to an acre, eliminates tearthumb.[18]

Cold Storage of Cranberries. (C. I. Gunness, H. J. Franklin, and C. R. Fellers.) The study of home cold storage of cranberries begun in 1936 was continued, the Department of Agricultural Engineering and the Department of Horticultural Manufactures cooperating with the Cranberry Station. A small insulated 4-room refrigerating plant was equipped at the Cranberry Station and berries were kept in it at 35°, 40°, 45°, and 50° F. Berries were also kept in cellar and other storage for comparison. A detailed report is not yet justified, but it is extremely interesting that it was found that partly ripe cranberries color up very much better at 45° to 50° F. than at temperatures either higher or lower than that.

Late Ripening and Keeping Quality of Cranberries. (H. J. Franklin.) A study of the relationship of the earliness of the ripening of cranberry crops to their relative keeping quality was based on the yearly records of first carlot shipments of the New England Cranberry Sales Co. from 1912 to 1937 inclusive, and the records of Dr. Neil E. Stevens of general cranberry keeping quality in those years. It showed that the crops that ripen late apparently always keep well.

COOPERATIVE CRANBERRY INVESTIGATIONS

Conducted by the Bureau of Plant Industry, United States Department of Agriculture, in cooperation with the Massachusetts Agricultural Experiment Station

H. F. Bergman, Senior Pathologist, U. S. D. A., in Charge

Development of Strains of Cranberry Resistant to False Blossom. (H. F. Bergman and W. E. Truran.) Reciprocal crosses were made during the past season between Early Black and the varieties Aviator, Centennial, McFarlin, and Shaw's Success; also between Centennial and McFarlin and between Centennial and Shaw's Success. In addition to these the following crosses were made: Early Black x Paradise Meadow, McFarlin x Aviator, McFarlin x Paradise Meadow, McFarlin x Shaw's Success, Shaw's Success x Aviator, and Shaw's Success x Paradise Meadow. Seeds from these crosses will be planted during January and February. Seedlings from crosses made in 1935 were set out on the bog during the past summer.

During the last week in August some 300-400 clones of wild cranberries were collected in Maine. Several different localities and habitats were represented in these collections. The vines were taken to East Wareham, where they are being stored over winter to be propagated in 1938. Vines collected in Maine in 1931 and 1932 have made slow growth on the bog due to very dry summers since they were set out, but many of them are now beginning to bear fruit. Several of the selected wild vines show very desirable vine and fruit characters under cultivation.

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[15] *Alnus incana* Moench.

[16] *Erechtites hieracifolia* Raf.

[17] *Bidens* spp.

[18] *Polygonum sagittatum* L.

Oxygen Content of Flooding Water in Relation to Injury to Cranberry Vines. (H. F. Bergman and W. E. Truran.) Measurements of the oxygen content of the water and of the light intensity at different depths were made on several bogs which were flooded during late May and early June for insect control. The minimum light intensity necessary to maintain the oxygen content of the water at a level high enough to prevent injury to the buds depends upon a number of interacting factors which vary from bog to bog. On one bog flooded to a depth of 12-16 inches the oxygen content of the water, at 22° C., increased as long as the light intensity at a depth of 12 inches did not fall below 12 percent of the full midday intensity. When the light dropped below 12 percent the oxygen content also decreased. The oxygen content of the water on all bogs examined was sufficiently high to prevent bud injury.

Spraying Experiments. (H. F. Bergman and W. E. Truran.) Preliminary experiments on the control of rose-bloom of cranberry showed that this disease may easily be checked by sprays. Although no spraying was done until the rose-bloom had developed fully, one application of 5-2-50 Bordeaux with rosin fish-oil soap as a spreader and sticker, applied at the rate of about 300 gallons per acre, greatly reduced the infection and two applications entirely eliminated it.

In spraying experiments for the control of fruit rots, Z-O, a copper fungicide of unknown composition, in concentrations of 1-50 or 1½-50, and Cupro K, a form of copper oxychloride, 1½-50, applied at the rate of 250-300 gallons per acre, gave much poorer control of rots than did Bordeaux 5-2-50 applied at the same rate. Bordeaux 5-2-50 with rosin fish-oil soap reduced the amount of rot to one-third to one-half of that of the check plots. Copper hydro 40 at concentrations of 4-50 or 5-50, applied at the rate of 250-300 gallons per acre, compared favorably with Bordeaux in the reduction of rot. On some plots it reduced the rot more than Bordeaux. On other plots on another part of the same bog Bordeaux gave the better control. A copper oxide spray made up with Cuprocide 1½-50, bentonite 2½-50, or Cuprocide 2-50, bentonite 3¾-50, applied at the rate of 250-300 gallons per acre, brought about a greater reduction in rot than did Bordeaux 5-2-50 applied at the same rate.

As Bordeaux with soap does not give a uniform spray deposit on leaves and fruits of the cranberry, various adjuvants in different proportions were added to the Bordeaux to determine whether better spread and adhesiveness could be obtained and the effectiveness of the spray thereby increased. Bordeaux 5-2-50 was used in all tests. To 50 gallons of this was added one of the following materials or combinations: Penetrol 1 quart; Areskap ½, 1, 2, 4, 8, and 16 ounces, respectively; Santomerse 2 and 10 ounces, respectively; bentonite 2½ pounds; bentonite 2½ pounds with 1 pound of rosin fish-oil soap; bentonite 2½ pounds with Areskap 1, 2, and 8 ounces, respectively; bentonite 2½ pounds with Aresket 4 ounces (Areskap, Aresket, and Santomerse are sodium salts of sulfonated diphenyl compounds). Determinations of copper in the spray residues on leaves were made within 1 to 2 days after the vines were sprayed and again shortly before the berries were picked. None of the materials used increased the amount of copper in the spray residue beyond that in the residue of Bordeaux made up with rosin fish-oil soap, although somewhat better distribution of the spray coating was obtained when 4-8 ounces of Areskap were added to 50 gallons of the spray than with the Bordeaux to which rosin fish-oil soap was added. On plots on which poor control of rots was obtained, it was found that the copper content of the spray residue was very low. Otherwise there was no evident relation between the amount of copper in the spray residue and the degree of rot control.

Blueberry Disease Investigations. (H. F. Bergman.) A blighting of flower clusters and new leafy shoots of blueberry caused by *Sclerotinia* was worse in

1937 than for several years previous, but was not sufficiently abundant to be destructive. As the season advanced, leafy shoots ceased to be affected, but the disease continued to affect the flower and fruit clusters up to the time that the fruits ripened, when typical "mummy" berries developed. A hybrid variety not grown commercially was worst affected. The disease also occurred to a considerable extent on Cabot and Pioneer.

DEPARTMENT OF DAIRY INDUSTRY

J. H. Frandsen in Charge

Nutritive Value of Chocolate Flavored Milk. (W. S. Mueller and W. S. Ritchie, Department of Chemistry.) Some of the results of this investigation have been published in the *Journal of Dairy Science*, 20 (6): 359-369, 1937.

The results of the previous year on the effect of feeding varying percentages of cocoa to white rats were checked on 16 male rats. At the end of six weeks the average gain of the rats on the various diets was as follows: No cocoa, 60.5 grams; 1 percent cocoa, 60 grams; 2.5 percent cocoa, 55.2 grams; 4 percent cocoa, 47.7 grams. These results confirm the previous findings.

In another experiment Dutch and American process cocoa were compared. Only one level of cocoa, 4 percent on a fluid milk basis, was fed. In addition to minerals and cane sugar, all of the diets contained 2 percent by weight of dried brewers' yeast, and two drops of cod liver oil were added daily to the ration. Twelve males and fifteen females were used in this experiment.

The average gain after six weeks was as follows:

No cocoa (control)	64.5 grams
Dutch process cocoa	65.3 grams
American process cocoa	60.5 grams

The rats receiving the American process cocoa did not do quite so well as those receiving the Dutch process cocoa. However, the most striking result from this experiment was the fact that there was no retardation in growth of the rats on the 4 percent Dutch process cocoa, as in previous experiments. As expected, the consumption of cocoa per day increased slightly when the diet was supplemented with yeast and cod liver oil. Since larger quantities of cocoa reduce the palatability of milk until the zero point is reached, it may be that this explains the observed lack of growth in the earlier experiments, rather than that the cocoa exerts a toxic effect. This phase of the problem is receiving further study.

Urine analysis. In order to secure information on the physiological action of cocoa, urine analyses were made. Samples over a period of 24 hours were collected from 12 animals, four rats on each of the following diets: No cocoa, 4 percent Dutch process cocoa, and 4 percent American process cocoa. The average results for five trials are given in the following table:

Kind of Cocoa	Volume per day c.c.	Specific Gravity	Acidity c.c. .1 NaOH	pH	Uric Acid mg. per c.c.
No cocoa (control)	4.6	1.043	2.3	6.72	0.2064
Dutch process cocoa	5.7	1.037	2.6	6.49	0.1913
American process cocoa	5.6	1.034	2.4	6.45	0.2023

In a general way, these results show no marked differences in the urine excreted by rats which received the Dutch and American process cocoas. However, differences were noted when the urine excreted by rats which received cocoa was compared with the urine of rats in the control group. Further trials are necessary before definite conclusions can be drawn.

Fecal pH studies. Fecal pH studies on samples collected from animals receiving no cocoa, 4 percent Dutch process, and 4 percent American process, showed no marked differences when the quinhydrone electrode was used.

Digestion of chocolate-flavored milk in vitro. The purpose of this study is to check, if possible, the results on the animal feeding experiments. Only preliminary experiments were made with whole milk powder plus cane sugar, alone and when supplemented with 4 percent of Dutch process cocoa (on a fluid milk basis). Digestion was carried out with artificial gastric juice, in a rotating machine set in an incubator at 37° C., in order that digestion might go on under conditions somewhat approaching those of the stomach. Samples were removed after five hours and analyzed for soluble nitrogen by the direct micro-Kjeldahl method. Preliminary results show that milk alone gives a greater total rise in soluble nitrogen than does the chocolate milk. However, it was observed in the preliminary work that the micro method was not sensitive enough and it will be replaced by the regular Kjeldahl method in further studies.

This year's work on the nutritive value of chocolate-flavored milk seems to indicate that when cod liver oil and yeast were fed, as good gains were noted in the rats receiving chocolate milk as with the control group receiving whole milk. The same amounts of yeast and cod liver oil were fed to both groups.

Some Factors Affecting the Properties of Whipped Cream. (W. S. Mueller.) Additional factors studied during the past year were the effect of agitating the cream after pasteurization and the effect of oat flour on whipping cream. The same whipping procedure was used in these investigations as was used in the previous studies.

Cream containing 30 percent butterfat was cooled over a surface cooler to 40° F. after pasteurization and then portions were subjected to one-half, one, and two minutes of agitation with the cream whipper. The cream was then aged for 24 hours at 40° F. before whipping. Results seem to indicate that preliminary agitation had no significant effect on maximum stiffness and serum drainage, and slightly decreased the overrun. The sum total of the preliminary and final whipping time was practically equal to the whipping time for the control, which was not agitated before aging. Effect of agitation after pasteurization at temperatures other than 40° F. are being studied.

The addition of 0.5 percent by weight of oat flour to whipping cream (30 percent butterfat) increased the viscosity, decreased whipping time, slightly increased maximum stiffness of the whipped cream, and slightly reduced the serum drainage, but had no significant effect on overrun.

The addition of a skim milk extract of oat flour to whipping cream (30 percent butterfat) had no significant effect on the viscosity of the cream or on the whipping qualities of the cream.

The Effect of Aging Treatments on Gelatin and Other Ice Cream Stabilizers. (W. S. Mueller.) A photo-electric tyndallmeter was developed in the dairy laboratory for studying the effect of aging treatments on the tyndall phenomenon of gelatin-water solutions. A detailed description of this instrument appeared in *Food Research* 2:51-54, 1937.

It was shown that the effect of gelatin in ice cream mixes can be increased by using a higher initial aging temperature. By cooling only to 68° F. after homogeni-

zation, and aging at that temperature for several hours, followed by aging at the usual temperature, a more viscous mix results, and the ice cream frozen from this mix showed a higher melting resistance. The gelatin content can be reduced by one-fourth by this method of aging. Gelatin-water solutions aged under comparable conditions after solution at 45° F. exhibited a similar difference in gel strength and basic viscosity. This study was continued by subjecting water solutions of sodium alginate, karaya gum, and oat flour to high initial aging temperature treatment as described for gelatin. These substances, which are used to some extent as stabilizers for ice cream, ices, and sherbets, did not exhibit the differences in gel strength and basic viscosity that were noted with gelatin. Further studies are being made with other stabilizers.

These results indicate that it would be of no advantage to an ice cream manufacturer to use a high initial aging temperature when using stabilizers such as sodium alginate, karaya gum, and oat flour, without gelatin.

Improving the Flavor and Keeping Properties of Milk and Some of Its Products. (W. S. Mueller and M. J. Mack.) It is generally conceded that the butterfat (including fat-like substances) is the major constituent affecting the flavor and keeping properties of milk and its products. A slight oxidative change in the butterfat content of the dairy product will produce flavor defects which are variously described as storage, cappy, cardboard, metallic, oxidized, and old ingredient. Among the many factors that have been mentioned as accelerators in the production of oxidized flavors in milk fat are light, heat, moisture, acidity, enzymes, and metals.

The addition of edible antioxidants to dairy products appears to be a feasible method for preventing or retarding oxidized flavors. The object of this study is to obtain more information on the effect of the following antioxidants on the flavor and keeping quality of dairy products: Carotene, ascorbic acid (Vitamin C), lecithin, cereal flours, and possibly ice cream stabilizers of vegetable origin. Most of the work to date has dealt with the effect of oat flour on the keeping property of ice cream, butter, frozen cream, whipped cream, and whole milk powder.

The use of only 0.25 percent of oat flour in ice cream mix delayed the development of off-flavors during the storage of the resultant ice cream, although 0.5 percent proved more effective. Oat flour also proved to have stabilizing properties. The stabilizing action of this antioxidant increased mix viscosity, improved the body and texture, and increased the melting resistance of the ice cream. When oat flour is added to the mix, a reduction should be made in the amount of gelatin or other stabilizer used if an overstabilized condition is to be avoided. The results indicate that a reduction of at least 25 percent of the gelatin content is desirable when 0.5 percent oat flour is incorporated in the mix. The use of oat flour as an antioxidant in ice cream is described in the October 1937 issue of the *Ice Cream Trade Journal*.

Oat flour, at the rate of one percent of the fat weight of the cream added to cream before pasteurization retarded the oxidative deterioration of butter. Also, the addition of an aqueous extract of this antioxidant to cream prior to pasteurization improved the keeping quality of the butter.

Butter was wrapped in parchment paper treated with oat flour, and stored at temperatures of 38° F. and 0° F. These samples have not been in storage long enough for marked differences to appear.

Cream containing two percent by weight of oat flour, which was added before pasteurization, was frozen and stored at 0° F. A control sample was also placed in storage at the same time. After three months in storage the cream was examined and no marked differences in flavor were noted, except that the cream containing

the antioxidant had a very pronounced oat flour flavor, thus showing that too much of the antioxidant had been added.

Two samples of whole milk powder prepared with and without oat flour by a commercial milk plant were examined. The milk powders were dissolved in water so that the total solids content was equal to that of normal fluid milk. The milk powder containing the antioxidant had a better flavor than did the control. This observation will be checked by determining the peroxide value of the fat. The amount of peroxide oxygen present in a fat serves as an excellent criterion of the degree of oxidation of that fat.

The effect of an antioxidant in whipped cream was also studied. Oat flour, 0.5 percent by weight, and also skim milk extract of oat flour were added to whipping cream before pasteurization. No marked differences were noted in the flavor of the whipped cream after one week's storage at approximately 36° F. It should be mentioned that the cream used in this experiment was of exceptionally good quality. The experiment will be repeated using a lower grade of cream and also a higher storage temperature for the whipped cream.

Trials will be made in the near future with other antioxidants of a non-toxic nature.

Sodium Alginate as a Stabilizer for Ice Cream. (M. J. Mack.) Previous studies have shown sodium alginate to be a satisfactory stabilizer for ice cream. Mixes containing the stabilizer were relatively uniform in viscosity, required no aging before freezing, and whipped readily to the desired overrun. The resultant ice cream was smooth in texture and possessed desirable melting characteristics.

This project is being continued with the study of another form of sodium alginate which may prove superior to that previously used.

The Stability of the Fat Emulsion in Cream. (M. J. Mack, in cooperation with Herbert Jenkins, New England Dairies, Inc.) A detailed study was made of the separation of oily droplets of butterfat from cream when used in coffee. This fat separation from cream in coffee is usually referred to as "oiling off". It is considered objectionable by some consumers and many buyers for restaurants and hotels. Therefore the dairyman should handle cream so that the defect will not occur.

The cause of the oily separation is the partial destruction of the normal emulsion of the fat globules in cream. Any factor or factors which will cause fat globules to coalesce may increase the size of some globules to the extent that they will rise to the surface in hot coffee and be readily apparent. The more important factors involved are as follows:

1. The separation of milk partially frozen during delivery will produce a cream capable of oily separation in coffee.
2. Separating temperatures higher than 90° F., excessive agitation of milk while preheating for separation, and the separation of cream higher in butterfat than 45 percent, decrease the stability of the fat emulsion.
3. Prolonged holding of cream at the pasteurization temperature increases the amount of destabilized fat in cream. The partial filling of pasteurization vats causes similar undesirable results. Stainless steel or glass-lined steel vats with slow propellor or paddle agitation and a heating medium of 160° F. produced satisfactory results. However, an increase in the speed of agitation or in the temperature of the heating medium, in these same vats, increased the oiling off tendency. Coil vats, regardless of the temperature of the heating medium, destabilized the fat emulsion. Heating cream to pasteurization temperatures higher than 145° F. increased the amount of oil separation slightly. Whether cream is agitated slowly or not at all during the holding period apparently made no difference, but rapid agitation caused oiling off.

4. Pumping cream from pasteurizer to cooler by proper size centrifugal pumps had no effect on the fat emulsion, while the use of oversize pumps destablized the fat to some extent. Steam piston pumps do not affect the fat emulsion adversely; in fact, with cream which oiled off badly, the piston pumps partially re-emulsified the fat which had separated.

5. Cooling cream in the pasteurizing vat was found to be very undesirable regardless of the type of agitation employed. The final temperature to which cream is cooled over a surface cooler does not affect the fat emulsion so long as freezing to the cooler does not occur. Freezing of cream to the cooler was found to be one of the most serious causes of oiling off of cream in coffee.

6. Aging cream (without agitation) at low temperature caused no change in the stability of the fat emulsion. Shipment at low temperature also had no effect unless the cans were only partially filled, thus allowing for agitation, which proved harmful.

7. Reducing the fat content of pasteurized cream by the addition of milk or skim milk had no effect on the tendency of the cream to oil off.

8. Cream which had been improperly handled, so that droplets of oil would separate from it if used in coffee, was made entirely stable by homogenization at the pasteurization temperature. A pressure of 500 pounds was used. Attempts to re-emulsify the fat by the use of a colloid mill and manually operated emulsor were partially successful.

9. Storage of cream for three days in a household refrigerator did not increase the tendency to oil off when the cream was used in coffee.

A Study of the Changes that Occur in the Storage of Frozen Sweet Cream. (H. G. Lindquist.) The effect of adding sodium alginate (cocoloid) in amounts of .05, .1, and .15 percent to 32 percent cream was studied. Sodium alginate increased the viscosity of the cream before freezing. There was a slight increase in pH, and the frozen cream containing sodium alginate showed less tendency to oil off when thawed than did the frozen pure cream. When thawed, the frozen cream containing sodium alginate whipped up into a firmer whipped cream with less drainage than did the frozen pure cream.

A Study of the Efficiency of Water Heaters, Electric Sterilizers, and Electrically Operated Cooling Tanks. (J. H. Frandsen, H. G. Lindquist, and Myer Glickstein.) Electric water heaters were studied to determine whether they could be used effectively as sterilizers when used to generate steam. In general, they were found satisfactory if utensils were exposed to the steam for four to eight minutes after they had been thoroughly washed. As a rule, the electric sterilizers and steam generators are of simple construction and easy to operate.

The effect of increasing the wattage in the heating element by 500 units does not produce any decided or comparable difference in the destruction of bacteria. Perhaps this is due to the great variation with which the bacteria are rinsed from the cans. However, it took less time to generate steam with the larger heating element.

A Study of the Possibilities of Milk, Cream, and Plastic Cream in the Development of New Products such as Combinations with Honey, Fruits, Cheese, and other Flavors of Various Kinds. (J. H. Frandsen and Myer Glickstein.) A study of the use of plastic cream and cheese in combination with certain fruits and nuts has been made and the work is being continued.

The successful incorporation of sweet fruits, sub-acid fruits, candies, nuts, and certain aromatic ripened cheeses to bases such as plastic cream and cream cheese proved to be popular and lent a variety of appeal to the palate. The

proper proportions and methods of handling have been determined and it was found that, although in most instances the combinations were successful, the use of fresh, canned, or frozen strawberries and peaches produced a mild flavor unless reinforced with fruit extract. The chocolate combination was the poorest according to the consumers' comments. Butter pecan proved to be the most popular. Storage of these types of spreads is limited to two weeks at 45°-50° F. The consistency and body of these spreads were good in all cases where drained fruits were used.

Further experiments with new and desirable flavors will be undertaken, and the addition of dried aromatic plants to milk to be made into cheese offers many possibilities.

A Study of the Effect of Organic and Inorganic Iodine on Some of the Milk and Digestive Enzymes. (J. H. Frandsen, W. S. Mueller, and Myer Glickstein.) A previous study on the effect of inorganic iodine on the enzymes revealed the fact that enzymatic activity was inhibited in most cases if sufficient iodine was added to the substrate. In the present study, similar experiments are now being conducted in an endeavor to note the effects of organic iodine on the enzymes as well.

Results up to date show that in concentrations as high as 100 p.p.m. of both types of iodine, the activities of different enzymes are affected differently.

When the substrate is not preserved with toluene, organic iodine stimulates catalase activity more than does inorganic iodine. Both kinds of iodine, however, showed a fairly marked increase in the production of oxygen by catalase over the control series containing no added iodine. In those samples preserved with toluene, there is no difference between the inorganic and organic iodine.

In the case of peroxidase, the control and the inorganic iodine series showed little appreciable differences in their purpurogallin numbers. The organic iodine group, however, showed an increase in peroxidase activity by over five times that of the other two groups.

Over a period of 16 days' incubation there was an increase of .159 percent acidity, in reference to lipolytic activity, for the control group, as compared to .0855 percent and .1000 percent for the inorganic and organic iodine groups respectively.

The results also showed a rather marked stimulation of rennin activity by organic iodine when compared with the group containing no iodine. Inorganic iodine is not quite so effective in stimulating this enzyme as is organic iodine.

In reference to steapsin or pancreatic lipase, the control and organic iodine groups are practically similar in their effects. In the case of inorganic iodine, there was a marked inhibitory effect on this enzyme.

Work is now in progress with the proteolytic enzymes such as pepsin, trypsin, and protease. No results can as yet be given on these enzymes.

DEPARTMENT OF ECONOMICS

Alexander E. Cance in Charge

Recent Changes in Consumer Demand for Milk and Some Factors Affecting it. (David Rozman.) In connection with this project, field work was carried on in Northampton, Holyoke and Pittsfield. In each of these cities information was obtained from individual families representing a cross section of the population, on the consumption of fluid milk at the time of the investigation as well as the

trend over a period of several years. An effort was made to determine the effect of important factors on the trend of milk consumption especially as it is influenced by various regulatory measures and retail price policies. A total of 306 family schedules was obtained in Northampton, 751 in Holyoke and 719 in Pittsfield. From the preliminary tabulations so far obtained it appears that the average consumption of milk in these cities varied from 6.45 pints per week per capita in Northampton, to 6.87 in Holyoke and 5.47 in Pittsfield.

The available information points to the fact that a lower rate of consumption in Pittsfield has been partly due to the higher prices for retail milk, while in Holyoke lower prices for delivered milk and the fact that a considerable number of the people bought their milk from the store at lower prices accounted for higher consumption. However the deficiency in fluid milk consumption in Pittsfield was compensated to a certain extent by a greater use of canned milk, as it appears that about one-half of the families included in this survey purchased this product, as compared with only one-fourth in Holyoke.

Land Use Problems in Massachusetts in Relation to the Balanced Program of Land Utilization. (David Rozman.) The work on this project was originally inaugurated in cooperation with the Bureau of Agricultural Economics and the Agricultural Adjustment Administration, and for two consecutive years has been carried out under two projects: A Study of Adjustments in Farming by Regions and Type-of-Farming Areas, from the standpoint of Agricultural Adjustment and Planning, including Soil Conservation; and A Study of Farm Organization and Soil Management Practices in Massachusetts in Relation to Agricultural Conservation and Adjustment, with Special Reference to the Formulation of a Program under the Soil Conservation and Domestic Allotment Act.

In the process of the work it has become apparent that the pattern of land use in Massachusetts is extremely varied and complicated and that a basis for an adequate land program should include the study of other important land uses in Massachusetts, covering recreational, forestry, industrial, part-time farming, and other developments. During the past year it has been possible to make considerable advance in providing an adequate basis for a land use program in cooperation with the State Planning Board and the W. P. A. organization. A complete survey of land resources was carried out covering all the rural areas of the State. The results are being reproduced in a series of maps showing the most important physical characteristics by individual towns.

Five basic maps are being prepared for each town, drawn to the scale of two inches to the mile. The first map shows the existing land use and cover for individual tracts of land, indicating areas devoted to various agricultural uses, types of forests, recreational uses, as well as industrial, commercial, and residential developments. The second map in the field survey indicates the exact location of roads and buildings by their type and condition. A special map is devoted to the character of the soil, classified in several groups on the basis of productivity and adaptability for agriculture, forestry, and other uses. Other information includes the topography of each town by means of contours with 20-foot intervals, and also roads and waterways. With the results of this survey available it will be possible to work out a program for scientific land classification indicating the area especially adapted for agriculture, as well as for forestry, recreational, industrial, and part-time farming development.

DEPARTMENT OF ENTOMOLOGY

A. I. Bourne in Charge

Investigation of Materials which Promise Value in Insect Control. (A. I. Bourne and W. D. Whitcomb, Waltham.)

Oil Sprays for Dormant Applications. The outstanding features of the winter of 1936-37 were the unusually high temperature and the light snowfall. The high mean temperatures of January and February have only been exceeded three or four times since the weather records were first taken in 1889. The weather during March, however, was somewhat colder than usual and there was very little development of fruit buds, so that by early April the season was approximately normal. The snowfall was light throughout the entire winter and most of it melted soon after it appeared; consequently, by early spring the ground was clear of snow, free from frost, and conditions in the orchards for spraying were the best in years.

During April the normally cool weather was interrupted by occasional very warm days which stimulated rapid development of fruit buds. These warm periods were often followed by sudden drops to comparatively low temperatures. Growers found it difficult to cover their orchards in time, and considerable oil injury to the opening buds occurred as a result of the low temperature immediately following application.

European red mite was so scarce in the college orchard that there was not sufficient material on which to check the efficiency of different oil sprays. Most of the trees showed no infestation at all. One new type of oil, which had just appeared on the market, was tested as to its relative safety on different varieties of fruit trees. This oil spray comprised a mixture of 96 percent petroleum oil and 4 percent phenol derivatives. It contained no emulsifying agent but was prepared for spraying by the addition of a goulac-bentonite emulsifier to the water before the oil was poured into the spray tank. The use of such an oil involved extra steps in preparation. The final spray mixture, however, proved very stable and no injury to buds or retardation in seasonal development was evident.

Substitutes for Lime-sulfur in Summer Sprays for Orchards. These tests were conducted in cooperation with the Departments of Pomology and Botany. Two copper fungicides were used in post-blossom sprays following the standard spray program through the calyx application. One of these was also used throughout the season. Liquid lime-sulfur 2-100 with spray catalizer, 2 pounds in 100 gallons, was used in pre-blossom and calyx sprays, and wettable sulfur thereafter. Spray catalizer is a spreader, sticker, and corrective agent in the lime-sulfur–lead arsenate combination. Tests were continued with diminishing strength lime-sulfur at 1-50 strength in pre-pink, 1-60 in the pink and 1-75 in the calyx, to secure adequate scab control and avoid injury to foliage. A mixture of dry lime-sulfur and 325-mesh sulfur was applied in a complete schedule throughout the season. All of these materials were used in combination with lead arsenate at the strength of 4 pounds per 100 gallons in the calyx, 1st and 2d cover sprays; 3 pounds per 100 gallons in the pre-pink, pink and 3d cover; and 2 pounds per 100 gallons in the 4th cover. They were also compared with the standard spray program recommended for Massachusetts, including liquid lime-sulfur in the pre-blossom and calyx sprays and wettable sulfur thereafter. Because of the prevalence of scab an emergency application of fungicides was made on June 22 between the 2d and 3d cover sprays.

Characteristic spotting and crimping of the leaves followed the application of the copper sprays on all varieties; also considerable russeting of fruit. There

was more leaf burn than usual following the standard spray program and very slight difference in visible injury between the modified lime-sulfur programs and the standard. The dry lime-sulfur–sulfur combination caused noticeably more foliage injury, and spray catalizer much less damage than the standard program.

The season was the most difficult one in recent years in which to attempt to control either disease or insect pests. Unfavorable weather frequently interrupted the spray schedule, especially during the critical period before bloom, and lessened the efficiency of the different applications. The relative merits of the different sprays were based on the results on the variety McIntosh as follows:

Material Tested	Percentage of Clean Fruit	Percentage of Fruit Showing Injury from—			
		Scab	Curculio	Codling Moth	Spray Russet
Coposil throughout season	22.6	56.7	29	8.4	100
Coposil 3d and 4th cover sprays	69.8	22	6.6	2.8	15.6
Copper Zeolite 3d and 4th cover sprays	73.1	8.5	16	3.2	19.5
Spray catalizer	58.5	20.9	18	3	4.1
Lime-sulfur modified	57.5	15.7	25.7	4.6	2.1
Dry lime-sulfur and 325-mesh sulfur	42.6	21.6	34.6	7.9	0.6
Standard program	67	2.4	23.4	6	1.7
Check	0.0	92.3	35.1	21	0.0

Sprays to Control White Apple Leafhopper. The infestation by the second generation of the white apple leafhopper in eastern Massachusetts in 1937 was the most severe in recent years. Examinations of untreated trees in 5 different orchards showed an average of 5 to 20 leafhoppers per leaf during the first week in September.

Orchard applications of pyrethrum dust 30-70 were generally unsatisfactory. In most cases there was a good knockdown of leafhoppers but a rather rapid recovery and reinfestation. A leaf count in one orchard showed a reduction from 8 leafhoppers per leaf to 2, and in several instances a complete cleanup resulted on those branches receiving a direct blast from the duster, but the insects were affected but little where exposed only to dust drift. Applications from the two sides of the tree were more effective than from one side. Favored by hot weather and timely treatments, nicotine–lime dust (2.4 percent nicotine) gave very good control in one orchard and provided excellent protection to the foliage.

A check on the effectiveness of spray materials applied by the orchardist was very confusing and discouraging, apparently due to an uneven application of the spray. For example, an examination of 100 leaves showed an average of 1.04 leafhoppers per leaf, but 60 leaves had 15 hoppers or an average of 0.4 per leaf while the other 40 leaves had 89 hoppers or 2.2 per leaf. In another case, 100 leaves averaged 0.55 per leaf where 60 leaves had no hoppers and 40 leaves had 55 hoppers.

Under these conditions, counts indicated a good reduction in leafhoppers from nicotine and pyrethrum materials used with soap. When counts were made 5 and 8 days after spraying, it appeared that the number of hoppers decreased with time where nicotine was used, but that the number of hoppers increased with time where pyrethrum was used.

In laboratory experiments with pyrethrum and cube dust and with pyrethrum

and nicotine sprays, all leafhoppers were killed in 24 hours. When the leaves were dusted with pyrethrum before the hoppers were confined, all of the insects were also killed in 24 hours. Experiments with these materials at constant temperatures of 60°, 70°, and 80° F. showed a slight but not consistent increase in effectiveness at 80°.

Summer Sprays for European Red Mite. Laboratory and orchard trials, in eastern Massachusetts, of some of the newer insecticides, especially those which might control both the white apple leafhopper and the European red mite, indicated that the nicotine and pyrethrum materials were ineffective against the red mite, but that the cyclohexylamine derivative gave good control at dilutions of 1-400 and 1-200.

Control of the Squash Vine Borer. The average field infestation by the squash vine borer in Hubbard squash at Waltham in 1937 was 3.68 borers per vine, which is three times as heavy as last year. The borer moths were late in appearing and the first treatment was not applied until July 9, followed by 3 additional applications at weekly intervals.

The liquid sprays were consistently superior to the dusts although the cube–clay dust containing 0.6 percent rotenone was nearly as effective. As in other years, the spray consisting of nicotine sulfate 1-500 plus summer oil emulsion 1-100 was the most effective treatment and reduced the borer injury 88.59 percent. The wettable cube spray using 4 pounds in 100 gallons of water showed a reduction of 81.53 percent, and being less expensive would seem more practical. Contrary to the results in 1936, the pyrethrum–clay dust containing 30 percent pyrethrum powder was ineffective.

Treatment	Number of Plants	Average Number of Borer Tunnels per Vine	Percentage Reduction over the Check
Check	25	3.68	
Nicotine sulfate 1-500+Oil emulsion 1-100	19	0.42	88.59
Wettable cube spray, 4 lb. in 100	28	0.68	81.53
Nicotine sulfate 1-250	22	0.77	79.08
Cube — clay dust, 0.6 percent rotenone	25	0.84	77.81
*Derris — clay dust, 0.6 percent rotenone	27	1.48	59.79
Pyrethrum — clay dust, 30 percent pyrethrum	29	2.06	44.03

*1936 Derris powder; others, 1937 powders.

Control of Striped Cucumber Beetle on Melons. Striped cucumber beetles were normally abundant in 1937 and killed or damaged seedling melons, cucumbers, and squash which were unprotected. On cantaloupes at Waltham, a part of which were transplanted and a part seeded on June 7, it was necessary to apply insecticides 5 times beginning June 10 and ending July 10. Although these applications were made at approximately weekly intervals, no definite period for treatments could be determined and the plants were sprayed and dusted whenever the abundance of the beetles warranted it. During this period several of the untreated seedlings were killed.

The effectiveness of the field treatments was determined by counts of the number of beetles present on the plants at different periods. A spray of wettable cube powder containing 3.65 percent rotenone and used at the rate of 4 pounds in 100 gallons of water reduced the number of beetles 90 percent, compared to the untreated plants, and was the most effective treatment. Cube-clay dust containing

0.6 percent rotenone ranked next in effectiveness with an 85 percent reduction in beetle population. Calcium arsenate–monohydrated copper sulfate–lime dust 10-20-70, and copper oxychloride–clay dust 1-14 (Dupont "A") were nearly as effective but caused slight to moderate burning of the cantaloupe foliage. Cryolite–clay dust 20-80 (Nat. Sulfur Company) and Cryolite Spray (Nat. Sulfur Co.) 4 pounds in 100 gallons gave 74 and 73 percent control, but the spray also caused some plant injury. Pyrethrum–clay dust 30-70 and tetra methyl thiuram disulfide (Dupont) 1 pound in 100 gallons, as a repellent, were the least effective treatments. However, the latter material seemed to protect the plants from serious injury in spite of a large number of beetles present.

Yield records corresponded with the striped beetle control, and the plants treated with cube–clay dust yielded 2.03 harvested fruits per vine compared to 1.35 fruits on the untreated vines. Based on yield, pyrethrum–clay dust, thiuram disulfide spray, and copper–calcium arsenate–lime dust were good, while the copper oxychloride dust was not significantly better than no treatment.

Control of Cabbage Maggot with Mercury Compounds. In 1937 the infestation by the cabbage maggot at Waltham was the most severe in ten years. Only 1 percent of the untreated cabbage plants produced a salable head and 95 percent of them were killed or severely injured. The roots of most of the untreated plants and those having ineffective treatments were attacked by 30 to 40 maggots, and only an abundance of rain which stimulated the growth of secondary roots above the maggot injury prevented a total loss of these plants.

The first eggs were found on May 7, this being the seventh consecutive year when eggs were first found between May 6 and 10 at Waltham.

Corrosive sublimate, 1 ounce in 10 gallons of water, was applied on May 8, 16, and 22, and continued to give good protection. Two applications of this material on May 8 and 16 gave 98 percent commercial control and yielded 82 percent large and medium heads. A single treatment on May 16 was more effective than one application on the other dates and gave 80 percent commercial protection with 90 percent satisfactory heads.

When pure calomel was dusted on the roots at the time of transplanting, 92 percent commercial protection was obtained and the yield was high. Calomel mixed 1 – 1 and 1 – 3 with clay gave less actual control of the maggot but provided sufficient protection to produce over 90 percent satisfactory heads. Calomel and clay 1 – 9 gave only 54 percent protection, indicating insufficient toxic action.

When the roots of cabbage were dipped at transplanting in a suspension of calomel and various adhesive materials, the protection provided by this coating was inadequate. For this purpose, calomel was used at the rate of 16 grams and 4.8 grams in a gallon of water. It was apparent that the amount of calomel was insufficient rather than that the method of application was faulty. Among the adhesive materials, laundry starch (1¾ ounces per gallon) and a synthetic wax soluble in cold water (1¼ ounces per gallon) were the most satisfactory, while solutions of liquid rubber, gum arabic, and locust bean gum were less effective. When Semesan (10 grams per gallon) was substituted for the calomel, the plants were killed or severely injured, and corrosive sublimate at the rate of 1 ounce in 10 gallons of water combined with the adhesive materials was ineffective.

Results of these and previous experiments indicate that a thorough dusting of the roots of cabbage plants with calomel powder at the time of transplanting gives safe and effective control of the cabbage maggot and can be recommended.

The cabbage maggot was also a serious pest of radishes at Waltham in 1937. Since the insect attacks the edible part of the radish, injury to this crop is more destructive than injury to cabbage.

Plantings at different periods showed great variation in the natural field infestation, the earliest planting being almost a total loss where no treatment was made.

Date Seed Sown	Date Radishes Examined	Percentage of Radishes Not Infested	Moderately or Severely Damaged
May 4	June 4	5	92
May 17	June 16	41	41
June 16	July 15	20	63

Treatments with calomel gave some protection but were less effective than on cabbage and generally not commercially practical as applied. Seed treatments with calomel reduced the infestation 20 to 30 percent but permitted moderate or severe damage to 30 to 70 percent of the radishes. Two or three applications of calomel spray (1 ounce in 10 gallons of water) at weekly intervals beginning when eggs were first found reduced severe damage about 45 percent in the May 4 planting, but were less effective on later plantings. Due to burning and stunting of the plants, corrosive sublimate solution 1-1280 cannot be used safely on radishes.

Control of Onion Thrips. (A. I. Bourne.) At the outset of the growing season weather conditions were very favorable for a rapid growth of the onion plants and at the same time served to retard the development and spread of thrips. This was borne out by the excellent appearance of the onion fields throughout the entire Valley up to the last of June and by the fact that at that time there were practically no thrips in evidence. On the college plots, counts made on June 24 showed most of the plants still uninfested, and comparatively few with one or two thrips per plant. Unusually high temperature and an excess of rainfall during May and June were the chief contributing factors to bring about such favorable conditions.

The early half of July, however, was characterized by extremely hot weather and almost no rain. In the 5-day period from July 7 to 11, the maximum daily temperature was 90° F. or above and reached 96° on the 8th. No rainfall occurred during this period. More ideal conditions for the development of blast could hardly have been produced artificially. Thrips multiplied rapidly during this time and developed the heaviest infestation in recent years. Blast, however, overshadowed all other pests. This began to appear by July 12, within ten days had spread throughout the entire Valley, and by the end of the month plants in many fields had broken down and were dead.

In the experimental plots the thrips infestation was insignificant until early July. On July 6 it averaged 22 thrips per plant. It increased to 40 thrips per plant by July 13 and by July 19 reached 45 which represented an average of less than 3 thrips per linear inch of plant. By July 26, however, the response of the thrips to the excessively hot weather of July 7 to 11 produced an average of 138 thrips per plant. By that time many plants were killed by blast and by August 3 practically all of the plants were dead.

The intervention of blast caused such a migration of thrips from dying plants to those which were slower to succumb that no authentic data could be secured relative to thrips-resistant varieties, although up to the time blast became prevalent both the Valencia and Riverside varieties showed less than one half the infestation of Danvers and were making more rapid growth. Blast appeared on these varieties as soon as on Danvers but their vigorous growth resisted its effects, and as late as August 10 some plants were still alive when all the Danvers were dead.

Blast appeared so early and spread so rapidly through the experimental plots

that there was no opportunity to study the effects of contact sprays upon either the insects or the plants.

There was no evidence of the fungus disease of thrips which for several years was very effective in reducing the numbers of the insects. By the time this disease would have normally appeared, there were few, if any, onion plants which had not succumbed to blast

The Spray Residue Problem. (A. I. Bourne.) Although no further reductions in the limit of tolerance on lead residues were made for the shipping season of 1937, growers found the problem of residue prevention complicated by weather conditions.

During the early season the spray program was often interrupted by frequent rains, and proper timing of applications was practically impossible. Scab control proved to be especially difficult and necessitated the use of emergency sprays. Considerable burning of foliage and russeting of fruit resulted from the frequent heavy spraying to control this disease.

Work of previous seasons has shown that unless weather conditions are very favorable, any spray after the 2d cover spray might build up excessive residue. The emergency scab spray of late June increased this danger. The rainfall between this emergency spray and the 3d cover spray and between the 3d and 4th cover sprays was not sufficient to allow the normal removal of the residue. These successive applications, therefore, built up formidable amounts of spray deposit which the three heavy storms of August removed partially but not sufficiently to eliminate the danger of excessive residue. As a result in many orchards the fruit showed excessive amounts of residue at harvest.

A study was made of phenothiazine as a possible substitute for lead arsenate. Both these materials were used in the 4 cover sprays in a block which had received the standard spray program up to that time. The same wettable sulfur fungicide was used with both materials. No spray injury to foliage or fruit followed the use of either material. The difference in control of insect pests between the two materials was slight but in all cases in favor of lead arsenate as shown in the following table.

Material	Percentage of Clean Fruit	Percentage of Fruit Showing Injury from—		
		Curculio	Codling Moth	Minor Insects
Phenothiazine.....	71.6	20.1	4.1	3
Lead arsenate.....	77.9	17.8	2.9	1.1

The chief drawbacks to the use of phenothiazine in its present form appear to be inferior suspension qualities and lack of adhesiveness.

The codling moth problem is the one which in most cases leads the fruit grower into difficulties from excessive spray residue on harvested fruit. In Massachusetts much of the damage is due to late season "stings" or shallow pits caused by young 2d brood larvae in August and September. Arsenical sprays at that season build up an excess of spray residue, and to remove it involves the washing of fruit; contact sprays require frequent applications and are expensive.

A study was made of possible measures to supplement the present spray program, and of these the use of chemically treated codling moth bands seemed the most promising. These were used in an orchard where it was estimated that from 75 to 80 percent of the 1936 crop showed codling moth damage. The bands were placed on the trees about June 15 and were examined October 21, after the crop was harvested. In late spring, in preparation for banding, the trunks and main branches of the trees in the test blocks were thoroughly scraped to remove loose bark. At that time many of the trees yielded 80 or more overwintering codling moth larvae. When the bands were examined in the fall, a total of 4,078

larvae was collected. This is an average of 16.4 larvae per band. The greatest number taken from one band was 84. Less than a dozen of the trees failed to show any larvae in the bands and these were trees without a crop.

It is generally recognized that the benefits from treated bands are not realized in full until the season following their application. In this orchard, however, there was a material reduction in the number of stings in the harvested fruit. The larvae destroyed by these bands represent a potential population in 1938 of more than 100,000 codling moth larvae figured on the basis of approximately 40 eggs per female. It has been estimated that the use of codling moth bands in an orchard with heavy infestation is equivalent to at least one extra spray, and the cost is only a fraction of that of the spray application.

Apple Maggot Control. (A. I. Bourne and W. D. Whitcomb.) Apple maggot was of comparatively minor importance in 1937. In the well-sprayed commercial orchards there was practically no injury, and even in the smaller home orchards less damage than usual was noted. The insect has receded from the front rank of orchard pests in the last few years. This decline in numbers is due in large measure to timely spraying, more attention to orchard environment, and concerted action on the part of the growers.

Date of Emergence of Apple Maggot Flies, Waltham

	In Sun		In Shade	
	Cultivated	Sod	Cultivated	Sod
		Light Soil		
1st fly	June 28	June 30	July 2	July 11
25% flies	July 15	July 10	July 15	July 20
50% flies	July 19	July 15	July 18	July 23
75% flies	July 21	July 19	July 22	July 26
		Heavy Soil		
1st fly	June 29	July 10	June 28	July 10
25% flies	July 12	July 16	July 18	July 17
50% flies	July 19	July 20	July 23	July 19
75% flies	July 26	July 25	July 27	July 27

The percentage of apple maggots which transformed to flies in 1937 (21.37) was the smallest since these records have been taken, and a decrease in the winter survival was indicated for the fourth consecutive year. In spite of this decrease, the influence of soil and atmospheric conditions was consistent with previous records and the greatest emergence was found in the cages having cultivation, light soil, and sun compared to sod, heavy soil, and shade. The first flies appeared in the cages located in the sun, and sod was the most important factor in delaying emergence. The influence of light and heavy soil was less significant than in other years.

Although the season of 1937 was generally late, the time of emergence of apple maggot flies in the cages corresponded more closely with that of 1936 than with that of 1935.

Introduction of Parasites of Oriental Fruit Moth in Peach Orchards. (A. I. Bourne.) Through a cooperative agreement with the Entomology Department of the Connecticut Agricultural Experiment Station, larval parasites of the oriental fruit moth were available for commercial peach orchards. More than 11,000 specimens of *Macrocentrus ancylivorus* were liberated in late June and early July in 36 peach orchards in 7 counties of the State.

Although the very mild winter of 1936-37 was a favorable one for the hibernation of insects, early inspection of peach orchards revealed a very light twig

infestation and also indicated practically no survival of parasites from liberations 3 years previous. Late-summer twig collections showed that the fruit moth had built up a heavy infestation, and considerable damage to midseason and late varieties was found in many orchards. One of the orchards in which twig infestation was heaviest and in which the most damage was found in fruit at harvest was located alongside a large planting of quinces. While injury to the peach crop was extensive, the quince crop was ruined. This further confirmed the belief that quinces are highly flavored by oriental fruit moth and constitute a serious threat to any peaches grown in the immediate vicinity.

Potato Spraying Experiments. (A. I. Bourne.) Flea beetles appeared early and were unusually abundant throughout most of the season over the entire State. Even in well-sprayed fields, they proved difficult to control.

Leafhoppers appeared late in the summer and were not abundant enough to cause any damage. Potato aphids during the hot, dry weather in July threatened serious outbreaks, but timely applications of nicotine checked the pest so successfully that no serious injury was caused even in fields of early varieties such as Irish Cobbler.

In the experimental plots, different insecticides were tested on the standard late-season variety, Green Mountain. Twelve applications of Bordeaux mixture were made between June 10 and August 27. Two rotenone compounds, nicotine tannate, a pyrethrum extract, and calcium arsenate were tested in combination with 5-5-50 and 5-3-50 Bordeaux mixture in the applications from July 9 to August 12. The ranking of the different materials on the basis of flea beetle control was as follows:

With 5-5-50 Bordeaux		With 5-3-50 Bordeaux	
Material	Average Number of Punctures per Leaf Cluster	Material	Average Number of Punctures per Leaf Cluster
Cubor (rotenone)	306	Derris	192
Derris (rotenone)	326	Cubor	231
Calcium arsenate	341	Nicotine tannate	302
Nicotine tannate	433	DX	333
Check (Bordeaux only)	488	Calcium arsenate	334
DX (pyrethrum)	520	Check (Bordeaux only)	355

In both combinations the rotenones were about equally effective and decidedly ahead of all other treatments. Both were much more effective in the low-calcium Bordeaux. Calcium arsenate gave equally good protection in both combinations. Nicotine tannate showed to better advantage with 5-3-50 Bordeaux, and the effectiveness of DX, the pyrethrum extract, was greatly increased in this combination. The fact that all the materials gave better control with the 5-3-50 Bordeaux would indicate that their action may be somewhat inhibited by the excess lime of the 5-5-50 combination.

Very general and often severe burning of foliage resulted from the July sprays, many of which were applied at extremely high temperatures. While these frequent applications were unavoidable because of the prevalence of flea beetles, the injury seriously checked the growth of the plants and the set of the tubers. In many cases the plants never fully recovered from this setback so that, on the whole, the yields were comparatively light, as shown in the following table.

Material	With 5-5-50 Bordeaux			With 5-3-50 Bordeaux		
	Yield per Acre Bushels	Percentage of Crop Grade 1	Grade 2	Yield per Acre Bushels	Percentage of Crop Grade 1	Grade 2
Check (Bordeaux only)	261.7	75	11.5	257.5	67	18.5
Calcium arsenate	396.6	83	8.6	270.8	77.5	10.5
Derris (rotenone)	321.7	82.3	9.1	302.5	82.6	8
Cubor (rotenone)	267.5	71.6	13.1	253.4	71.7	15.7
Nicotine tannate	264.1	84.5	6.6	293.4	82.7	7.3
DX (pyrethrum)	245.9	79.3	9.8	270.8	77.8	11

All of the materials gave higher yields when combined with 5-5-50 Bordeaux except nicotine tannate and DX. The yield in the plots of these last two materials reflected the improved control of flea beetles which they furnished when combined with 5-3-50 Bordeaux.

Spray injury was very severe on the plots sprayed with 5-3-50 Bordeaux. This undoubtedly explains the reduced yield.

Two commercial brands of copper sprays for potatoes were compared with the two strengths of Bordeaux mixture. Since many growers have expressed the belief that lime alone would give sufficient protection against blight and insects, it was applied to one plot. The comparative yield following these treatments is as follows:

Material	Yield per Acre Bushels	Percentage of Crop Grade 1	Grade 2
Bordeaux 5-5-50	344.3	79.8	7.8
Bordeaux 5-3-50	308.8	76.5	11.9
Copper hydro (Chipman Chemical Co.)	306.6	79.6	11.1
Basic copper sulfate+lime (Sherwin-Williams Co.)	300.7	78.7	12.2
Lime alone	263.2	67.6	18.4

When the potatoes were dug, nearly 1 percent of the crop in the lime plot showed the presence of rot. Sample hills examined earlier in the season showed a much higher proportion of rotten tubers, which led to the belief that many diseased tubers had completely disintegrated by time of digging and that the difference in yield between this plot and the others would more accurately indicate the actual loss due to disease.

The comparative yield in the other plots follows very closely observations made through the season on the relative amount of leaf burn. Considerable injury was noted on the plants sprayed with 5-3-50 Bordeaux and the two commercial sprays. The increased yield in the 5-5-50 Bordeaux plot reflected the superior condition of those plants and their longer period of growth.

Insecticides for the Control of European Corn Borer. (A. I. Bourne.) The studies carried out in 1937 in cooperation with the Federal European Corn Borer Laboratories, included field experiments in Hampden County with dual-fixed nicotine, a newly developed nicotine tannate-bentonite dust, and continued tests with derris and nicotine tannate sprays on two farms in Worcester County. Both sprays and dust were applied as nearly at 5-day intervals as weather would permit, beginning with the first appearance of the young borers in the field. In every case the earliest maturing variety of sweet corn grown on the farm was used in the tests.

Between June 10 and July 5, the period during which applications were made, rain fell on 13 out of the 26 days, and the total precipitation recorded was 4.1 inches. The season was decidedly unfavorable for both sprays and dusts. The

frequent rains interrupted the 5-day schedule and often occurred soon after the materials were applied. At least twice it was necessary to make a reapplication following the rain so that 5 applications of sprays and 6 of the dust were made.

There was considerable difference in the infestation on the three farms. In the plot dusted with dual-fixed nicotine, 6 percent of the treated plants and 36 percent of the checks showed stalk infestation. In the derris plot, 5 percent of the sprayed and 12 percent of the checks were damaged by borers. In the treated plots the infested stalks were not often seriously damaged and for the most part they contained only 1 or 2 small, young stage larvae, whereas in the checks the stalks were badly riddled, often contained from 5 to 8 mature borers, and in many cases had broken down before the ears had fully matured. The loss of vitality to the plants caused by even a light or moderate infestation is clearly reflected in the yield records as shown by the following table.

Material	Percentage of Infestation	Increase of Treated over Untreated Plots	
		Increase in Total Ears per Acre	Increase in Uninfested Ears per Acre
Dual-fixed nicotine (dust)	30	225	1562
Derris (spray)	5	1692	2052

In every case the treated plots showed an increased total yield over the checks. On the basis of uninfested ears, the difference was even more pronounced. Even in the case of a comparatively light infestation as in the derris plots, an advantage of more than 2,000 ears per acre represented a considerable profit to the grower.

A more significant index of the value of the treatments is the relative proportion of Grade 1 corn harvested from the experimental plots as shown in the following table.

Material	Percentage of Total Yield			
	Uninfested		Grade 1 ears	
	Dusted Plots	Check Plots	Dusted Plots	Check Plots
Dual-fixed nicotine	92.8	70	76	48
Nicotine tannate	97.6	94.4	72	60
Derris	98.3	94.9	88	81

The field containing the derris plots was heavily fertilized. The corn made excessive stalk growth and many of the ears did not fully develop and were graded as culls. Since the total yield in this field, however, was at the rate of 24,000 ears per acre, even the small difference of 7 percent represented an increase of 1,680 ears.

Since the growers could guarantee borer-free ears, they found a steady demand for their corn and disposed of the crop at a premium. So few of the ears in the treated plots were infested that the growers were able to eliminate the expense of time and labor ordinarily necessary to examine each ear for borers, thus making a material reduction in their marketing costs.

Insects Concerned in the Dispersal of Dutch Elm Disease. (W. B. Becker.) Research work on the biology of the native elm bark beetle, *Hylurgopinus rufipes* Eich., was continued. Freshly cut American elm logs in which eggs were laid in the fall of 1936 and in which the insects passed the winter as larvae were again attacked by new adults in the spring of 1937 for oviposition purposes. Some slight emergence began from these logs early in July and kept up at a very low rate until early in August when the daily emergence increased considerably. At that same time emergence started from logs which had been cut in the early

spring of 1937 and were attacked for oviposition purposes for the first time when the above-mentioned logs were attacked for the second time. Emergence continued until late in November when occasional live, newly emerged adults were found in the outdoor cages.

The results of scouting work carried on in 1935, 1936, and 1937 to determine the distribution of elm bark beetles in Massachusetts show that *Scolytus multistriatus* Marsh., the smaller European elm bark beetle, is distributed over a wide area in eastern Massachusetts, and is also found in southwestern Massachusetts; Egremont, Great Barrington, New Marlborough. The identity of the finding previously repor ed in Westfield, based on the occurrence of two empty brood galleries in an American elm, typical of those of *Scolytus multistriatus*, is now considered uncertain, due to the fact that Westfield is approximately twenty-five miles distant from known limits of the infestation centering at New York City; intensive scouting in the vicinity since then has failed to reveal the presence of the beetles; and detailed study made by this office of the types of brood galleries dug by *Hylurgopinus rufipes* shows that occasionally they construct a single unbranched egg gallery parallel to the grain of the inner bark such as *Scolytus multistriatus* digs instead of the two-branched, more or less transverse egg gallery usually constructed. Until further scouting reveals the actual presence of the *Scolytus multistriatus* beetles in Westfield, this office will consider the previous report uncertain. Adult beetles were collected in all the other towns mentioned. Eastern Massachusetts: Merrimac, Haverhill, Methuen, Tyngsborough, Tewksbury, Andover, North Andover, Boxford, Georgetown, Topsfield, Wenham, Beverly, Danvers, Billerica, Reading, Woburn, Stoneham, Saugus, Revere, Winthrop, Lexington, Sudbury, Weston, Waltham, Belmont, Newton, Brookline, Boston, Wellesley, Natick, Dover, Westwood, Walpole, Canton, Easton, Abington, Rockland, Brockton, Marshfield, Bridgewater, East Bridgewater, Halifax, and Plymouth. *Hylurgopinus rufipes* was found in every section of the State scouted. The only sections not scouted were Cape Cod and the islands off the coast.

A bulletin of a popular nature dealing with the Dutch elm disease and its insect vectors was prepared in conjunction with Doctor M. A. McKenzie of the Botany Department.

Other Elm-Boring Insects. Studies on the habits of two elm-boring insects, *Saperda tridentata* and *Magdalis* sp., were continued. In one cage experiment with *S. tridentata* the adult beetles confined their feeding to the leaves and the current season's twig growth. In some indoor experiments, adult Saperdas which emerged in late winter, when given leafless winter twigs to feed on, attacked only the twig growth of the previous season.

Insect Pests of Shade and Ornamental Trees. A detailed survey was made of the insect pests of the shade and ornamental trees on the campus as a basis for the development of a seasonal spray program.

Fifty-six species of insect pests of various shade and ornamental trees and in addition six types of insect pests of house timbers were sent to the laboratory for identification and information on control.

Apple Leaf-Curling Midge. (W. D. Whitcomb, Waltham.) The apple leaf-curling midge (*Dasyneura mali* Kieffer) was normally abundant in the infested area. In one of the oldest infested orchards, however, the first generation was apparently less abundant than previously, but with the development of the following generations the infestation was equal to that in other years.

In Westford, the activity of this insect began about a week later than in 1936, the first eggs being found May 25, and the first appreciable number of mature maggots was collected under bands on June 22. Eggs of the second generation

were abundant from July 2 to 15, and mature maggots were leaving the rolled leaves from July 27 to August 10. A distinct third generation developed on young trees from eggs laid August 20 to 25 and mature maggots were plentiful September 7 to 14. It is now definitely established that a third generation of this midge develops in a normal season and that it can become very abundant on young trees or wherever new growth is available.

No new infestations outside the known infested area were discovered.

Natural enemies, especially *Triphleps insidiosa* Say, were slightly more abundant and active than in other years but failed to cause any noticeable reduction of infested tips.

Control studies were conducted on small trees partly interplanted among old trees and partly in separate blocks. The susceptibility of the different varieties in this orchard was determined by counting the maggots in the rolled leaves of 10 typical infested tips on June 12. The result is as follows:

Variety	Number of Leaves	Number of Maggots	Average Number of Maggots Per Leaf
Baldwin	36	2503	69.5
McIntosh	45	2352	52.2
Starking	45	2048	45.5
Golden Delicious	39	1094	28.0

Experimental sprays were applied 5 times (May 25, 28, June 1, 4, 8) during the oviposition period of the first generation, and again 5 times (July 6, 9, 13, 16, 20) during the corresponding period of the second generation. Although some trees received sprays at both periods, no trees received the same spray materials at both periods. Records were taken by counting the number of infested tips and the degree of injury on each sprayed tree and the number on the nearest unsprayed tree of the same variety and corresponding size.

In general, the protection resulting from spraying was disappointing and from 25 to 60 percent of the tips were infested on the sprayed trees, although only about 10 percent of the tips were moderately or severely infested. Less control was obtained on Starking trees than on McIntosh, Richared, or Golden Delicious. Spraying for control of the first generation reduced the infested tips by 46 to 12 percent. Wettable cube powder containing 3.65 percent rotenone, used at the rate of 6 pounds in 100 gallons, with the addition of 3 pounds of water soluble diglycol stearate wax as a spreader and sticker, applied to McIntosh and Richared 3-year-old trees was the most effective treatment. Nicotine sulfate and molasses, nicotine sulfate with fish oil soap and karaya gum, and a nicotine bentonite wettable powder with a commercial spreader called Ultrawet gave moderate control. Summer oil diluted to 1 percent plus fish oil soap failed completely.

In the second generation experiments, nicotine sulfate 1-800 plus molasses 3 percent was the most effective, and reduced the infestation 48 percent on Golden Delicious. The cube–wax mixture was again good and averaged the best for both series. When nicotine sulfate 1-800 was added to the summer oil–fish oil soap mixture which had failed previously, the control became good although the test was inconclusive because of poor growth on the trees.

A count of the maggots in 10 typical rolled leaves on sprayed trees during the larval period of the second generation showed that the number was reduced in proportion to the effectiveness of the spray in preventing infestation.

Although valuable information regarding the effectiveness of insecticides has been obtained, the only logical conclusion that can be drawn from this work is that spraying alone is not a practical means of combating the apple leaf-curling midge.

Control of Plum Curculio in Apples. (W. D. Whitcomb, Waltham.) In 1937 the emergence of plum curculio beetles from hibernation was later than normal and only 2 percent of them were in the trees when the calyx spray was applied to Gravenstein and McIntosh on May 19. By May 24, when Baldwin and Wealthy received the calyx spray, the number of beetles in the trees had increased to 11 percent, and jumped to 32 percent on May 29.

Due to the acute scab situation at that time, an early calyx application was advisable. On McIntosh, lead aresenate could have been safely omitted from the calyx spray but on the more rapidly growing varieties such as Gravenstein, Duchess, Transparent, and Baldwin, it was necessary for the best curculio control.

The critical period in curculio activity extended from May 25 to June 2 with the maximum injury occurring from May 30 to June 1.

In the experimental orchard, which was heavily infested with curculio, studies were begun to determine whether the size of apples during the critical period influenced the control by spraying. Gravenstein apples sprayed with lead arsenate at the rate of 4 pounds in 100 gallons on May 25, when the average diameter of the fruit was 5.04 sixteenths of an inch, had 54.24 percent of the fruit stung. McIntosh which measured 3.94 sixteenths of an inch in diameter when sprayed on May 30 had only 16.14 percent of the fruit stung. Wealthy and Baldwin apples measuring 4.20 and 4.26 sixteenths of an inch when sprayed on May 30 and May 28 showed 18.83 percent and 16.38 percent stung fruit respectively. These preliminary experiments showed that the apples (Gravenstein) which measured approximately 5/16 inch in diameter when sprayed suffered about three times as much curculio injury as those apples (Baldwin, Wealthy, McIntosh) which were approximately 4/16 inch in diameter when sprayed.

Biology and Control of Carrot Rust Fly. (W. D. Whitcomb, Waltham.) The field infestation by the carrot rust fly was moderately light at Waltham in 1937, and the untreated carrots showed 14 percent commercial injury by the first generation. Some injury to celery was reported by market gardeners but this pest was not one of major importance this season.

Treatment of the seed at planting with pure calomel powder gave 99 percent protection, again demonstrating that this is a practical treatment for early carrots exposed to a light infestation. When the calomel was mixed with equal parts of clay as a seed treatment, 4 percent of the carrots were commercially injured; but when the seed was treated with a 1-3 mixture of calomel and clay the carrots showed as much injury as the untreated planting. The addition of powdered gum to the calomel failed to increase the adhesion of the calomel to the seed and gave unsatisfactory results.

Four applications (June 5, 12, 19, and 26) of cube–clay dust to carrots from seed sown May 4 gave complete protection from this insect, and can be recommended.

Adaptability of Cryptolaemus to Control of Mealybugs in the Greenhouse. (W. D. Whitcomb and William Garland, Waltham.) Studies of the development and activity of *Cryptolaemus montrouzieri* at controlled constant temperatures of 60°, 70°, and 80° F. were continued. In the 1937 studies this insect was stimulated at 80° considerably more than in previous observations, although the results again indicated that 80° is slightly excessive and that 70° is nearer the optimum.

Temperature	Average Number of Days Beetles Lived	Average Number of Eggs per Female Beetle	Average Number of Days for Incubation of Eggs	Percentage of Larvae Hatched	Average Larval Growth in Days	Average Number of Mealybug Eggs Eaten by Larvae	
						During Life	Per Day
60° F.	60	50.5	15.0	30.5	*99	1338	14.85
70° F.	65	97.0	8.7	50.7	43.9	1279.8	29.2
80° F.	90	182.0	6.01	38.0	32.3	1217.4	37.6

*Only 1 larva completed growth at 60° F.

Oviposition approximately doubled with each increase of 10° in temperature, and the number of days required for larvae to hatch from eggs was 2½ times as many at 60° as at 80° F. Although the percentage of eggs from which larvae hatched in these studies was low, it was significantly higher at 70° than at either 80° or 60°. At 60° only 1 larva completed development and, therefore, the results at this temperature should not be considered representative. At 80° the average larva ate 1217.4 mealybug eggs or 37.6 per day for 32.3 days; while at 70°, 29.2 eggs were eaten each day for 43.9 days, making a total of 1279.8 eggs eaten by each larva and thus indicating the greatest protection against mealybug damage.

Preliminary experiments in feeding adult beetles on adult mealybugs indicate that a beetle will eat about 1½ mealybugs per day at 80°, and half a mealybug per day at 60° and 70° F.

Control of Red Spider. (W. D. Whitcomb, Waltham.) In studies of insecticides used for the control of red spider on carnations and greenhouse plants, materials containing rotenone continued to show a high toxicity against this pest and generally became more effective as the temperature increased. The addition of wettable sulfur as a fungicide to one of the rotenone sprays caused no material change in the number of red spiders killed. In comparable tests most of the newer commercial insecticides containing rotenone were inferior to the older standard mixtures or to laboratory preparations. Suspensions of derris, cube, or pyrethrum powder in water were less effective than the extracts of these materials, and the addition of a wetting agent did not increase their effectivness in the laboratory.

A commercial potassium-seleno-sulfide spray was only moderately effective, and the addition of wettable sulfur increased the value of the combination only slightly. With this material the percentage of spiders killed was greater 5 days after spraying than it was after 10 or 15 days, but the number of live spiders on the sprayed plants was much smaller after 15 than after 5 days.

Lubricating oil emulsions were more effective at 60° F. than at 80° but the more volatile kerosene emulsion was more effective at 80°.

Naphthalene and Similar Compounds as Greenhouse Fumigants. (W. D. Whitcomb, Waltham.) Preliminary studies of naphthalene derivatives indicate that these materials are quite toxic to red spider and have promising possibilities as greenhouse fumigants.

In experimental fumigations using the materials at the rate of ½ ounce per 1,000 cubic feet vaporized in 6 hours at a temperature of 70° F. and a relative humidity of 60-65 percent, 75 to 95 percent of the red spiders were killed in one fumigation, and 95 percent or more in two fumigations. Naphthalene base materials in the form of oils or light waxes vaporized satisfactorily, but the heavier waxes gave off a thick smoke and a powdery precipitate which made them undesirable for practical use. When 1 part of wax was dissolved in 2 parts of oil, each of the combinations used killed 60-70 percent of the spiders in one fumigation, and about 95 percent in two fumigations. The addition of naphthalene or paradichlorobenzene crystals to the oil gave similar results. Crude forms of the naphtha-

lene base oils and waxes were less effective than the more refined forms. Although the safety of these materials to plants has not been definitely determined, no serious injury has resulted so far.

In cooperation with the Boston Edison Company, an electrically controlled fumigating stove for use with naphthalene and similar compounds was developed and tested. This unit, which was composed of electric heating elements and a container for the fumigant, was designed to fumigate 7,000 to 10,000 cubic feet. The heat was adjusted by a series of contact switches and a rheostat having a range of approximately 75 to 175 watts, producing a temperature of 150° to 400° F. in the fumigant. When this unit is adjusted, the fumigant will be vaporized at a uniform rate automatically. The operating cost for these units is surprisingly low but at present the manufacturing cost is high.

FEED CONTROL SERVICE

Philip H. Smith in Charge

The Feed Control Service comprises not only feed inspection, but several other activities, as listed below:

Feed Control (General Laws, 1920 Chapter 94)
Seed Control (General Laws, 1927 Chapter 94)
Dairy Law (General Laws, 1920 Chapter 94)
Advanced Registry Testing
Miscellaneous Work

Feed Control. (P. H. Smith, A. F. Spelman, J. W. Kuzmeski, F. A. McLaughlin, J. T. Howard.) During the fiscal year 1,791 samples of feeding stuffs were officially collected and examined in the control laboratories. The gross receipts from the registration of feeding stuffs in 1937 (calendar year) were $23,020, derived from 1,151 brands at $20 each.

Dairy Law. (P. H. Smith, J. T. Howard, H. L Allen.) During the year ending December 1, 1937, 6,686 pieces of Babcock glassware were tested. Condemned glassware consisted of one pipette. One hundred certificates of proficiency were awarded; and 224 creameries, milk depots, and milk inspectors' laboratories were visited in order to check methods and pass upon equipment in use. As a result of this inspection, one machine was condemned.

Advanced Registry Testing. (P. H. Smith.) Advanced registry testing has been supervised by this department since its beginning in 1902. There are now on yearly test 386 cows located on 45 different farms. This does not include the herd tests where all animals in each herd are placed on test. There are 39 of these, 6 of which are supervised by men sent out from this office and 33 by cow-test association supervisors.

Miscellaneous Work. (P. H. Smith, A. F. Spelman, J. W. Kuzmeski.) Numerous analyses have been made for residents of the State and other departments of the college.

Summary of Miscellaneous Work, 1937

Materials sent in:	
Milk and cream, butterfat only	919
Milk, solids and fat	27
Ice cream, for fat	96
Feeds, from farmers and dealers	98
Feeds, from State Institutions	235
For other departments of Experiment Station and College:	
Dry matter, forage crops	385
Complete fodder analyses	37
Vegetables, fiber only	60
Grass and hay, water and protein	158
Feeds, fat and fiber	57

FERTILIZER CONTROL SERVICE

H. D. Haskins in Charge

Fertilizer Inspection. (H. D. Haskins, H. R. DeRose, J. W. Kuzmeski, A. F. Spelman, Chemists; L. A. Graves, C. L. Whiting, G. E. Taylor, Sampling Agents; Harry L. Allen, Laboratory Assistant.) Records for the year show that 117 firms have registered for sale in the State of Massachusetts 497 brands of mixed fertilizer and fertilizing materials and 51 brands of agricultural lime and gypsum. Results of analysis show that 68 percent of the mixed fertilizer brands, 79 percent of the unmixed fertilizer brands and 80 percent of the lime brands showed no deficiencies. The gross receipts from the registration of the fertilizer and lime products and from fertilizer tonnage fees for the year 1937 were $15,372.19.

For about ten weeks, beginning April 1, three experienced men employed to draw samples for inspection purposes sampled 21,314 sacks or containers, representing 17,858 tons of materials; 191 towns were visited, and 1,819 samples representing 549 brands were drawn from stocks found in the possession of 599 agents or owners. The following summary shows the character of these substances, as well as statistics with reference to their inspection.

	Brands Registered	Brands Collected	Samples Drawn	Number of Analyses	Number of Determinations
Mixed fertilizers	307	308	1,028	444	7,967
Ground bone, tankage and fish	45	45	151	69	708
Nitrogen products, mineral and organic	53	50	205	115	522
Phospho ic acid products	26	26	109	31	276
Potash products	17	17	69	28	145
Dried pulverized natural manures	32	31	107	35	335
Nitrate of potash	5	5	11	5	36
Peat products	3	3	4	3	30
Wood and cotton hull ashes	7	6	12	12	99
Miscellaneous	2	6	10	6	98
Lime products	53	54	25	56	591
Totals	550	551	1,831	804	10,807

During the period July 1, 1936 to July 1, 1937, the tonnage of fertilizer and plant food sold in Massachusetts was as follows:

	Fertilizer (Tons)	Plant Food Elements (Tons) Nitrogen	Available Phosphoric Acid	Potash
Mixed fertilizers	48,527	2,548	4,138	3,468
Unmixed fertilizer chemicals and materials	24,004	1,579	2,376	821
Pulverized natural manures	1,743	36	26	44
Totals	74,274	4,163	6,540	4,333

Full details of the fertilizer and lime inspection will be found in Control Bulletins 90 and 91.

Miscellaneous Analytical and Diagnostic Work. (H. D. Haskins, H. R. DeRose, A. F. Spelman, J. W. Kuzmeski.) Chemical studies in cooperation with several departments of the Experiment Station, Field Station, County Agents and men in charge of the Soil Conservation work of the state have been carried on. The character and extent of this work is shown in the following summary:

Apple spray residue	17	Fertilizers for research studies on magnesium and manganese	7
Apples for borax test	3	Field crops	44
Agricultural lime products (Soil Conservation work)	12	Garbage incinerator ashes	1
Cranberry spray residue	1	Nicotine solutions	1
Dog rations	2	Salt lick	1
Fertilizer mixtures and chemicals	26	Total	115

Other work of the department has included consultations on various projects where chemical problems were involved. Research on problems developed by the referees of the Association of Official Agricultural Chemists of North America has received the usual attention and has included work on methods for the determination of magnesium oxide and manganese in fertilizer mixtures, the chemical work involved in these studies being performed by Mr. J. W. Kuzmeski. A considerable variety of chemical work has, as usual, been done for other State Institutions, community organizations, firms and individuals having problems of agricultural interest. This group includes the analyses of the following materials:

Animal tissues for mineral poison	3	Fire-damaged fertilizer	6
Ashes of various kinds	4	Industrial by-products	8
Dried pulverized manures	5	Lime products	6
Food and forage products for mineral poisons	8	Miscellaneous	2
Fertilizers and fertilizer chemicals	15	Soils	11
		Total	68

DEPARTMENT OF FLORICULTURE

Clark L. Thayer in Charge

Breeding Snapdragons for Varietal Improvement and Disease Resistance. (Harold E. White, Waltham.) Rust resistance tests of approximately 50 species and strains of snapdragons in the field indicate that there is a wide variation in the degree of resistance to rust. Only six species of the total number studied showed no susceptibility; in a few cases the number of plants tested was so small that results are not considered conclusive.

Commercial garden varieties of snapdragons sold as rust-proof strains showed a high degree of resistance to rust, but such varieties are still in need of further selection for trueness to color and type of plant growth. Of 25 varieties tested, only six showed a high degree of purity in color and type of growth.

Some 35 commercial varieties of greenhouse snapdragons were tested for rust resistance under glass and, while there was some difference in degree of susceptibility, none were observed to be resistant. There was considerable variation in germination of seeds of commercial varieties which appeared to be due to immaturity of the seed.

Work with the development of Field Station strains of rust-resistant snapdragons is progressing. Winter flowering types which show promise have been developed for use under glass. Considerable difficulty has been experienced in getting rust resistance, color of flower, type of spike, and the winter-blooming character combined in one strain.

Study of the Effect of Plant Nutrients, Soil Reaction, and Light on Gardenias. (Harold E. White, Waltham.) On the basis of experimental results, preventive rather than corrective measures appear to be a more practical method of regulating iron chlorosis of gardenias. For three years it has been possible to prevent iron chlorosis consistently by keeping the fertility level of the soil low and by using a fertilizer mixture containing nitrogen in the form of organic materials such as tankage, milorganite, cottonseed meal, or in the form of ammonium sulfate. Fertilizer containing as low as 1 percent of nitrogen from sodium nitrate or calcium nitrate was sufficient to cause chlorosis. It is questionable whether an actual deficiency of iron occurs in the soil or whether iron compounds remain inactive in the soil. What would appear to be a more plausible explanation of chlorosis in gardenias is that antagonism between iron and certain nutrient elements — possibly calcium or sodium — takes place within the plant. Sulfur in a quantity as low as one half pound per 100 square feet of bench area was sufficient to prevent chlorosis; however, in quantities above one pound it had a definite retarding effect on the growth of the plants.

Phosphorus and potassium do not appear to have any influence on chlorosis. Added illumination of 25 to 50 foot-candles of light for 6 hours each day from September 1 to April 1 had no effect on chlorosis. Low growing temperatures were observed to produce a type of chlorosis which did not respond to iron treatments to the foliage and did not appear to be corrected by applications of ammonium sulfate.

Analytical data on chlorotic and normal plants show that plants fed with sodium nitrate were lower in iron content than plants fertilized with ammonium sulfate; also, sulfur increased the iron content of plants even though they were fed with sodium nitrate. Soil acidity does not appear to be a specific cause of iron chlorosis, as chlorotic symptoms occur over a wide pH range.

Propagation Studies with Gardenias. (Harold E. White, Waltham.) Technique and propagation methods do not appear to be concerned appreciably with the successful rooting of gardenia cuttings.

Propagation Studies with Geraniums. (Harold E. White, Waltham.) Losses of geranium cuttings by florists who propagate plants would appear to be due to black stem rot disease. Isolation and inoculation studies indicate that several fungus organisms are concerned in the rot of the cuttings. Treatment of the cuttings with different disinfectants and the sterilization of the propagating media had no effect in reducing the rot disease. Synthetic growth substances did not appreciably stimulate rooting of geranium cuttings.

Temperature experiments relating to the rooting of geranium cuttings show

that at a temperature of 60° F. the rot disease is less destructive than at higher temperatures. Geranium cuttings taken from stock plants grown under glass gave a higher percentage of disease-free rooted cuttings than did cuttings from field-grown plants. Bordeaux spray applied to plants in the field appeared to be harmful rather than beneficial, since cuttings from sprayed plants did not root as well as those from unsprayed plants.

Effect of Temperature on Forcing Lilies. (Harold E. White, Waltham.) A rooting temperature of 60° F. was found to be better than 50° for bulbs of *Lilium longiflorum* var. *giganteum*. The response was the same for southern-grown Japanese bulbs of 7-9 and 9-10 cm. in size. The blooming period was 10 days to 2 weeks shorter when bulbs were rooted at a temperature of 60° than when they were rooted at 50°. Bulbs rooted at temperatures of 70° and 80° and then grown in a temperature of 60° developed and flowered normally. Bulbs rooted at a temperature of 50° averaged 3.8 flowers per plant; at 60°, 4.3 flowers; at 70°, 3.85 flowers; and at 80°, 3.0 flowers per plant. On plants rooted in temperatures of 70° and 80° the internodes were longer than on plants rooted at 50° and 60°. Changes in growing temperatures at various stages of bud development did not cause splitting of the buds.

DEPARTMENT OF HOME ECONOMICS NUTRITION

Helen S. Mitchell in Charge

Cause and Control of Nutritional Cataract. (H. S. Mitchell and G. M. Cook.) Medical authorities state that there is as yet no effective therapeutic agent for the prevention or cure of cataract. While experimental cataract produced in rats may be quite different from a senile or other type of cataract in man, yet the lens is opaque in both cases and the mechanism of the change is unknown. The experimental approach with animals which have proved susceptible to this pathological change promises to yield results of fundamental importance which may ultimately suggest some effective clinical procedure.

The incidence and rate of development of cataract in rats may be controlled with some degree of accuracy by the amount of galactose fed, thus providing an experimental device for studying the possible influence of other dietary factors upon cataract production.

1. *Effect of other dietary constituents upon the cataract-producing action of galactose.* The cataract-producing action of lactose or galactose rations was not appreciably altered by

1. type of supplementary carbohydrate (starch, dextrine, sucrose, glucose).
2. type of fat (crisco, butter, mutton tallow, cod liver oil) or amount (2, 11, 22, and 44%).
3. addition of excess cholesterol (2½ and 5%).
4. amount of salt mixture (0, 4 and 10%).
5. shifting acid-base balance (4.76% Na citrate, 3.4% NH_4Cl).

6. amount of water ingested.
7. vitamin C administered orally or injected.
8. deficiency or excess of vitamins B_1 and B_2.
9. ingestion of large doses of dinitrophenol.
10. injection of lens antigen (from beef, sheep, guinea pig and rat).

These results were published in abstract form in the *Journal of Nutrition*, Volume 13, Supplement, page 18, 1937.

The type and amount of protein in the ration does exert a definite influence upon the rate and incidence of galactose cataract. Earlier work with protein variations failed to show significant differences because the proportion of the aggravating factor, galactose, was evidently too large. Subsequent work with lower levels of galactose (15% and 25%) has demonstrated that deficient protein (5%) markedly hastens cataract development and high levels of protein (45%) inhibit cataractous changes. Six different proteins from widely varied sources (casein, lactalbumin, beef, fish, egg albumin, and soy bean) are now being investigated and preliminary observations would indicate that the protective action against cataract is not the same for all nor does it correlate with their growth-promoting properties.

The demonstrable loss of sulfur-containing compounds from cataractous lenses suggested that the sulfur-containing amino acids might be crucial factors in metabolic problems. Large doses of cystine (1, 2, and 3%) had but a slight inhibitory effect and methionine is still under investigation. Preliminary findings were reported in the *Proceedings of the Society of Experimental Biology and Medicine*, 36:806, 1937.

2. *The relation of ingested carbohydrate to the type and amount of blood and urine sugar and to the incidence of cataract in rats.* A summary of this work was given in the 1936 *Annual Report* but publication was in the *Journal of Nutrition* 13:501, 1937.

A Study of the Nutrition of College Women with Respect to Vitamin C Requirements. (H. S. Mitchell and O. A. Merriam.) This project, initiated in the fall of 1936, is concerned with the vitamin C intake and excretion of groups of students most of whom are eating at the college cafeteria. The women of the classes of 1940 and 1941 have been experimental subjects during their freshmen year. The data accumulated to date seem to indicate that many students are borderline or below in their vitamin C intake as compared with generally accepted standards. A possible correlation of these findings with other measures of health or well-being is being investigated. The project will be continued for the balance of the school year.

The Relation of Iodine or other Minerals to the Prevention of Cholesterol-induced Atherosclerosis in Rabbits. (H. S. Mitchell and M. Goldfaden.) This research is being sponsored by the Lang Fund. It has been successfully demonstrated that gross pathological lesions of the aorta may be produced by feeding cholesterol to rabbits. When the amount and time of cholesterol feeding is so controlled as to produce moderate aortic lesions, litter-mate rabbits fed kelp in the ration along with the cholesterol may be partially or completely protected against these pathological changes whereas potassium iodide fails to give this protection. The cholesterol content of the blood of rabbits on these experiments indicates that there is some correlation between the circulating cholesterol and aortic lesions. Growth and general condition of the rabbits have continued satisfactory throughout the experiments. This study is still in progress.

DEPARTMENT OF HORTICULTURAL MANUFACTURES

W. W. Chenoweth in Charge

Cranberry Research. (C. R. Fellers, A. S. Levine, and W. B. Esselen, Jr.) This project has been supported in part by the American Cranberry Exchange. The use of dextrose in canned cranberry sauce is satisfactory provided the ratio of dextrose to sucrose does not exceed 1:3.

Cooperative cranberry storage experiments conducted for two years show that temperatures of 35°-40° F. are superior to higher temperatures for storing either semi-ripe or ripe Early Black and Howes cranberries. A paper entitled "Gas content of cranberries and possible relationship of respiratory activity to keeping quality" was published in *Plant Physiology* 12:527-536, 1927.

Cranberries contain approximately .03 percent total iron, 31 percent of which is "available" iron as determined by the alpha, alpha-dipyridyl method. Hemoglobin regeneration tests with anemic white rats fed cranberries as their source of iron also showed that about one third of the iron present was available. Cranberries are also relatively high in manganese and copper. At the present time the influence of cranberries in the diet on the utilization of calcium by the white rat is being studied. A paper entitled "Influence of certain fruits on fecal flora and intestinal reaction in diets of rats" was published during the year in *Food Research* 2:65-72, 1937.

Technological Investigations on Apples. (C. R. Fellers, A. S. Levine, J. A. Clague, and W. B. Esselen, Jr.) The work on canned baked apples has been continued. Among the better varieties for the purpose are Rome, King, York, Stayman, and Jonathan. Details of the canning process are being studied.

Cider champagne and other bottled apple beverages have been manufactured with a view to utilization of culls to better advantage than is now done. These beverages contain practically no vitamin C. By clarifying with commercial pectinase enzymes, very clear, attractive beverages can be prepared.

McIntosh and Baldwin apples, to the amount of 500 and 1000 grams daily, were included in neutral and acid-forming diets and eaten by young men. Blood alkali reserve was unchanged and urinary acidity but slightly increased as a result of the consumption of these large quantities of apples.

Currant Jelly. (J. Novick and C. R. Fellers.) A study has been made of the factors affecting yield and quality of currant jelly. Some of these factors are variety, maturity, extraction methods, concentration, finishing point criteria, and storage of the extracted juice. Accumulated data indicate that juice viscosity is a satisfactory criterion of jelly strength and yield. Since the currant contains no starch, treatment of the juice with diastatic enzymes has been of little value for clarification. Currants contain a little vitamin A and are an excellent source of vitamin C, but most of the vitamin C is lost during the process of manufacturing jelly.

Nutritive Value of Frozen Foods. (C. R. Fellers, C. F. Dunker, and D. De Felice.) A chemical method suitable for carotene determination in fruits and vegetables has been perfected and used to evaluate 18 fresh and frozen products for carotene content (vitamin A). The standard rat bio-assay method for vitamin A has been used to check the chemical determination in several cases. Spinach, squash, peas, snap beans, asparagus, broccoli, and carrots, in either the fresh or the frozen state, are good sources of vitamin A.

A careful study has been made for two seasons of the losses in vitamin C of spinach due to shipment, freezing, canning, cooking, and dehydration. The

steam cooking of spinach with but little water caused much better retention of vitamin C than did water cooking (320 units per ounce as compared with 156 was the average for 10 samples). Only moderate losses of vitamin C resulted from either freezing or canning. Dehydration caused complete loss of vitamin C and markedly decreased the vitamin A content. Freezing and canning of spinach had little effect on its vitamin A content.

A paper covering research on sweet corn was published in *Food Research* 2 (1):41-50, 1937.

Nutritive Value of Industrial Food By-Products. (C. R. Fellers, W. B. Esselen, Jr., J. Bernotavicz, and A. D'Ercole.) Work has been in progress on tomato and cranberry wastes, apple pomace, dried buttermilk, and distillers' wastes. Tomato waste consists of seeds, skin, and fiber and contains approximately 24 percent protein, 15 percent fat, 32 percent carbohydrates, 3 percent ash, and 20 percent crude fiber. Present also on a 100-gram basis are 680 international units of vitamin A, 300 Sherman–Bourquin units of vitamin G or 200 Norris–Wilgus chick units, 500 Sherman–Chase units of vitamin B, and a small amount of vitamin C. This product possesses distinct value as an animal and poultry feed but must be used with some caution because of poor palatability.

Dried distillers' grains and concentrated slop or syrup were likewise examined chemically and biologically. Both are good sources of vitamins G and B, but the growth-promoting quality of the proteins is poor unless they are supplemented with casein or other proteins.

Research is now under way to determine whether apple pectin (derived from pomace) has a vitamin A-sparing action and whether the presence of pectin in the diet affects the mucous membranes and mucin formation. No significant results are available.

Vitamin D Investigations. (W. B. Esselen, Jr., and C. R. Fellers.) Rickets resistance in rats cannot be correlated with either environmental temperature or diet ingredients within limits. The cause of spontaneous recovery in a colony following a period of rickets resistance is unknown.

Collaboration with committees of the A. O. A. C. and the American Public Health Association in referee work in connection with the establishment of standard assay methods of vitamin D has been continued.

Bio-assay of numerous samples of irradiated, fortified, and metabolized vitamin D milks produced in this State showed that the guaranteed amount of vitamin D was present in these milks and that they could be safely recommended as potent sources of vitamin D.

Various samples of poultry feeds and other preparations have been assayed for vitamin D.

Nutritive Value of Fishery Products as Human and Animal Food. (Cooperative with Chemistry. C. R. Fellers, W. S. Ritchie, J. A. Clague, and W. B. Esselen, Jr.) A paper was published (*Trans. Amer. Fish. Soc.* 66:415-421, 1937) on the nutritive value and utilization of the Atlantic Whiting, *Merluccius bilinearis*.

Home Canning Research. (A. S. Levine, W. A. Maclinn, and C. R. Fellers.) A bulletin (No. 341) covering the research and field work on vacuum–pressure relationships in glass canning jars was published this year. Three years' experience has demonstrated the value and utility of this new method of home canning wherein the wire bails on the glass jars are tightened *previous* to heat treatment. The method decreases markedly the losses of liquid from jars during processing, improves the appearance of the contents, saves time, obviates the

necessity of handling the hot jars after processing, and has no effect on either breakage or spoilage.

Work is under way on the utilization of cull turkeys by canning as meat and in the form of sandwich spreads and broth.

Ascorbic Acid in Tomatoes and Tomato Juice as Affected by Maturity, Variety, Method of Assay, and Other Factors. (W. A. Maclinn, A. S. Levine, and C. R. Fellers.) A second season's results on tomato varieties and strains have been obtained. The same varieties which were high in ascorbic acid in 1936 were likewise high in 1937. However, all varieties contained 20 to 35 percent less ascorbic acid in 1937 than in 1936. Hence, seasonal and varietal differences may greatly alter the ascorbic acid (antiscurvy value) of commercial tomato juices. Tomatoes picked when partly ripe are of the same ascorbic acid content as either freshly picked or stored ripe tomatoes. Preliminary data indicate that tomato juices canned either in glass or in tin containers do not decrease significantly in ascorbic acid content in four months' storage in subdued light at room temperatures.

Use of Corn Sugar in Fruit Products. (C. R. Fellers, C. W. Morrison, and H. A. Howard.) A paper summarizing results to date was published in *Indus. and Engin. Chem.* 29 (8):946-949, 1937. The work is being continued.

Possible Nutritional Aspects of Arthritis. (W. B. Esselen, Jr., and C. R. Fellers.) This research, conducted under the Lang Fund, has shown that iodine, kelp, or vitamins B, G, and D in the diets of rats and guinea pigs have no effect on the onset or the pathology of scurvy or the length of life of the scorbutic animal. The data show the great specificity of vitamin C and that the results of a deficiency of it cannot be influenced by minerals or by large amounts of vitamins B, G, and D. However, it was found that vitamin D did have a favorable action in decreasing the marked joint swelling ordinarily observed in severe scurvy.

Vitamin Content of the Maize Plant and Grain. (W. B. Esselen, Jr., B. Isgur (Agronomy), and C. R. Fellers.) A paper was published on this subject in *Jour. Nutrition* 14 (5):503-511, 1937.

Does Fertilization of Plants Affect Their Vitamin C Content? (B. Isgur (Agronomy) and C. R. Fellers.) Preliminary data have been published in *Jour. Amer. Soc. Agron.* 29 (11):890-893, 1937.

DEPARTMENT OF HORTICULTURE

R. A. Van Meter in Charge

Horticultural Value and Culture of Perennial Asters. (Ray M. Koon, Waltham.) The purpose of this study is to evaluate all the horticultural varieties and certain promising species of the genus Aster for garden use, discover the proper cultural methods, and develop new varieties of habit and color nonexistent at present. Inasmuch as Aster is a genus of nearly 2,000 species and synonyms of very intricate taxonomy, there is nothing to be gained by becoming involved in species-complexes.

Three hundred and twenty-five species and varieties assembled at Waltham from sources in America and abroad have revealed that (1) many varieties in the trade should be eliminated from nurserymen's lists and supplanted by others of proved higher garden value; (2) certain varieties originating abroad have been renamed upon their introduction to the American trade, resulting in confusion

as to nomenclature; (3) type species have been given horticultural names for the purpose of popularizing them commercially; (4) a few of the spring flowering species, namely subcaeruleus, alpinus and purdomi, can be forced during the winter under glass and may prove to be a profitable crop for the florist.

Data have been recorded as to the flowering date and duration of bloom, habit of growth, diameter of flower, and color of rays. Ridgway's Color Standards and Color Nomenclature has been used in identifying and designating the colors.

A list of recommended varieties for nurserymen to propagate and for gardeners to grow has been prepared.

At the request of the American Joint Committee on Horticultural Nomenclature the investigator has revised the list of Asters for the 1938 edition of Standardized Plant Names.

Transplanting and Packaging of Hardy Plant Materials. (George Graves, Waltham.) Seedlings of superior strains of hybrid Delphiniums, sown in two-inch pots in August 1936, transferred to tin pots of 3.6-quart capacity and eight-inch porous clay pots in October, and then carried over winter in a cold greenhouse (40°-45° F.), became thoroughly established in the containers, made little winter top-growth, and in late April or May (depending on individual vigor) were merchantable plants, each with one or more normal flower spikes. When planted in the field after first flowering, a heavier second and, in some cases, a third flowering took place. In this single test the impervious containers required less attention in winter and gave plants of more uniform growth.

Dormant field buds of Hybrid Tea Roses, potted in tins and clay pots in late November and carried over winter plunged in cold frames, made up into salable plants by midsummer. This preliminary trial in frames showed greater economy and more uniform results than did wintering the buds in a temperate general-purpose greenhouse without thought to the specific cultural requirements of the rose or to breaking of dormancy.

No growth differences were noticeable between checks and treatments on a test of spring-planted *Taxus media* var. *Hicksii* when colloidal waxes were applied to foliage and branches after receipt bare-rooted from another state.

Plants of some of the newer varieties of apples on Malling type stocks Nos. 1 and 4 which are being trained in eight-inch pots this year showed the characteristic influence of dwarfing understocks in that they did not put on late growth as in their first year after potting.

Plants now being grown to test locally produced forcing Lilacs in the winter of 1938-39 withstood the shock of potting in full leaf in early September, thus confirming the practice of handling field Lilacs in early autumn.

Clonal Apple Investigation. (George Graves, Waltham.) Preliminary efforts to build up a stock of plants for study is yielding a mixed assemblage of layers, sucker plants, vertically placed root cuttings which have regenerated top and roots, independently rooted etiolated shoots from horizontally placed root pieces and, in the case of one seedling of ornamental use, a few hardwood cuttings. These various sorts of plants are being produced entirely in the open field and without recourse to the application of auxin.

Preliminary comparison of results of these well-understood field methods of increase (from the point of view of the desirable properties of a satisfactory understock) indicates favorable promise on the part of etiolated shoots from horizontally placed root pieces.

Study of Hardy Ornamental Plant Material. (George Graves and Harold S. Tiffany, Waltham.) Of the 1340 species and varieties under observation at the beginning of the year, 128 were lost through death or through discard because of

worthlessness or redundancy. Further accessions then brought the collection up to a total of 1551 at the year's end. A continuing system of accurate graphic blooming records was started this year for all plants under observation.

Although all effort in this project is working towards evaluation of garden plants, particularly herbaceous materials, special emphasis is being placed on a few of the most confused groups, such as Hemerocallis, Garden Phlox, and Oriental Poppies. Of these three groups, the Daylilies have been well enough studied to show that, in the absence of standards for judging, many worthless or duplicate varieties have been introduced, also that commercial stocks are quite mixed. Sufficient data are yet lacking to permit determination of outstanding varieties.

Much of the herbaceous test material was this year mulched heavily with hay or shredded banana stems after the first spring hoeing and fertilizing. As has been reported elsewhere, mulching proved beneficial for large woody plants, both culturally and economically.

DEPARTMENT OF OLERICULTURE

Grant B. Snyder in Charge

Packet Seed Studies. (G. B. Snyder and W. L. Lachman.) A large majority of home gardeners buy their vegetable seeds from the neighborhood store in either packet or bulk lots. It has been found that seeds purchased in this manner frequently have a variable germination and are not true to the name under which they are sold. In order to check these factors, state inspectors purchased some 168 lots from various stores in the State. These included fifteen of the more important vegetables: beans, beets, carrots, cucumbers, sweet corn, tomatoes, cabbage, lettuce, onions, parsnips, peppers, radishes, spinach, and turnips.

Field notes on germination indicated fair to good vitality in most lots. There was some variation in trueness to name in the carrots and beets. Most of the other vegetables were within the type range.

Systematic Studies of Vegetables. (A. P. Tuttle, P. W. Dempsey, and G. B. Snyder.) During the past few years a large number of improved and new varieties of vegetables have been offered to the vegetable grower. Many of these newer sorts were planted in the trial plots along with the more standard sorts and comparatively evaluated for performance, quality, and adaptability to Massachusetts conditions. Some one thousand different lots covering more than 50 different kinds of vegetables were included in the trials.

Water Requirement of Vegetable Crops. (W. L. Lachman and G. B. Snyder.) Tomato plants grown in pots in the greenhouse responded well to heavy watering and the plants receiving the most water outyielded those plants with smaller applications. Applications of water in varying quantities to tomatoes also appear to influence the prevalence of blossom end rot. Studies conducted in the greenhouse indicate that heavily watered plants are as susceptible to blossom end rot as those which receive light applications of water.

Vernalization of Vegetable Crops. (W. L. Lachman.) While rutabagas may be vernalized, seed of cabbage soaked in water for twenty-four hours and stored at 0° C. for twenty-eight, forty-two, and fifty-six days have not thus far produced plants which initiate a flower stalk before a head.

Lettuce seed soaked in water and stored for ten days at 0° and −5° C. produced plants which initiated flower stalks earlier than those from seed not so treated.

Shape Index Studies of Tomatoes. (W. L. Lachman.) A study of ten strains of tomatoes on a quantitative basis revealed that there were no consistent changes in the shape of fruits during the season. A random sample of twenty-five fruits proved to be sufficient to accurately describe the shape of these varieties at any given period of time. There was a tendency for the largest fruits to be the flattest and at the same time the most irregular and ribbed.

Asparagus Investigations. (Robert E. Young, Waltham.)

Varietal Improvement. Individual harvest records for the selected asparagus plants were obtained, and these data completed the records necessary to correlate the relationship between the number of stalks produced during summer growth and the subsequent number and weight of spears produced during the next cutting season. There was found to be a very close relationship between growth and yield. This association permits the asparagus seed grower to select seed from the high-producing plants, thus making an improvement in the strain. The results of this investigation on relationship between growth and yield were presented for publication in *Amer. Soc. Hort. Sci. Proc.* 34, 1937.

Depth of Planting and Height of Cutting. There has been no change in the effect of the depth of planting on the yield of asparagus in this experiment during the last two years. This past season there was no difference in yield when the asparagus spears were cut with 8 inches of green or with 12 inches of green. The yield from the plot cut with 4 inches of green was considerably less than that for the other two plots.

The length of spear and production for the past season was as follows:

Len th of Spear	Average Yield per Plant (Grams)	Average Number of Spears per Plant	Weight per Spear (Grams)
4 inch Green	310	19.0	16.3
8 inch Green	461	15.3	30.1
12 inch Green	472	11.3	42.9

The data indicate that the asparagus plant continues to send up spears until all the reserve food is exhausted. The number of spears that plants will produce seems to depend on the size of the spear and the length to which it is allowed to grow. If the spears are cut too short, there is an insufficient number of buds on the asparagus crown to utilize all the reserve food supply of the plant.

Pascal Celery Storage. (Robert E. Young, Waltham.) The results of the storage experiments conducted during the past season confirm earlier results. Two experiments were conducted in growers' pits to determine whether results could be obtained under commercial storage similar to those obtained in the experimental storage. One of the growers obtained a 10 percent increase in marketable celery where the plants were packed loosely. This celery would have kept considerably longer had it been left in the pit. Celery packed in the regular way was mature and beginning to decay, at the time it was cleaned for market. Similar results were obtained in the other grower's pit except that the celery did not keep quite as well due to a different method of storage.

In the storage pit at the Station, the yield of marketable celery was almost one third greater when the celery was packed in the pit loosely enough to permit circulation of air than when it was packed tightly, as in commercial practice.

A paper presenting some of the results of heart growth studies with pascal celery has been published in *Amer. Soc. Hort. Sci. Proc.* 34, 1937.

Trellis Tomato Experiments. (Robert E. Young, Paul W. Dempsey, Harold A. Wilson, Waltham; Alden P. Tuttle, Amherst.) The trellis tomato crop for the past season was above the average in production. The foliage remained green all the way down the plant until frost. With such a good crop, many of the differences due to treatment that were observed last year were lacking this past season. The most outstanding treatment was the use of potted plants trained to a single stem. Plants treated in this manner produced almost twice as many early fruits as did the plants that were pricked out and then trained to two stems. All fruits picked before the price on the Boston Market dropped below one dollar per basket (24 pounds) are classed as early. This season the price received for early fruit was about three times as great as that received for the remainder of the season. Trellis tomatoes produced three times as many early fruits as did the same variety (Comet) when grown flat culture.

The soil on which the tomatoes were grown was a good loam and when weather conditions were favorable the various fertilizer treatments failed to affect the yield.

Vegetable Breeding for Improvement of Quality. (Robert E. Young, Waltham.)

Waltham Scarlet Shell Bean. Questionnaires sent to growers who had planted samples of this bean indicate that the growers consider it superior to other strains. The replies indicate that shell beans are one of the most difficult crops to grow and produce a first-class crop. On certain types of land the Waltham Scarlet does not do well. In general, this bean is increasing in popularity and there is insufficient seed available to supply the demand.

Waltham Beauty Pepper. During the past season, this pepper has continued to find its place and is increasing in popularity, particularly among home gardeners. It has proved to be a good pepper when grown within and north of Massachusetts, but when grown farther south it has a tendency to be shorter on the longitudinal axis. Plenty of seed of this variety is available.

Lettuce. Considerable progress has been made toward the production of a better acclimated New York type lettuce for Massachusetts. This project is in cooperation with the Division of Fruit and Vegetable Crops and Diseases of the United States Department of Agriculture. Selections from Columbia No. 1 which was developed by the cooperating agency have proved superior to the parent stock and considerably better than New York No. 12, the standard variety used by growers. This project has not been continued long enough to determine the value of the many lots of hybrids now in trial.

The F_3 generation of a cross between Bel-May, the forcing lettuce, and an English strain has produced a very promising crop in the greenhouse. The new hybrid has a better color and frame than Bel-May but has a slightly small head for our market. The hybrid will be back-crossed to Bel-May this year to further increase its size.

Tomatoes. The Waltham Forcing Tomato has continued to gain in popularity during the year. Almost all greenhouse growers who have tried this tomato have been able to obtain a better crop of higher quality tomatoes than with any other variety or strain tried.

Samples of the Waltham Forcing and a new Trellis Tomato No. 22 were sent to many trellis tomato growers. Many greenhouse growers who have been using the Waltham Forcing inside have also tried it outside. In general, both varieties have set a satisfactory crop but on some farms the fruit has been too small. At the Field Station the fruit has averaged four to five to the pound for the total crop. The particular advantage of these strains of tomato over other varieties that have been tested at the Field Station is the larger percentage of number one

fruit produced. During the past season some varieties produced as low as 16 percent number one fruit, while practically all the Station strains were above 50 percent, and a few produced 75 percent number one fruit. Further testing will be necessary before either of these varieties can be recommended with assurance.

Hutchinson Carrot. The supply of stock seed of the Station's strain of this carrot was maintained and increased. The use of this carrot has increased slightly during the year. Most market gardeners have expressed satisfaction with the carrot, but from the standpoint of consumers a better core and internal color would be an improvement. F_2 generation hybrids of Hutchinson crossed with a dark-colored selection of Tendersweet produced a very good colored crop of the same shape as Hutchinson. Due to the biennial habit of the carrot it will require several years to obtain a uniform strain. In testing carrot seed collected by the Bureau of Foreign Plant Introduction, one lot of seed was found that had exceptionally good color and a long root. A hybrid between this carrot and the Hutchinson carrot should have an extra small core of very good color.

Wyman Crosby Beet. The Field Station strain of Wyman Crosby beet has been perfected to the point where all characters are sufficiently satisfactory except the internal color. This beet when grown in the hot weather produces a high percentage of poorly colored beets; when grown in the cool weather of the fall, almost all of the beets are of a satisfactory color. Since the beet is a biennial and must be stored over winter, selection in the past has been made in the fall thus making improvement in color practically impossible. The method of selection has now been changed; the use of cold storage and the greenhouse has permitted the production of a crop during the summer. Approximately 90 percent of the roots were discarded in an effort to produce better color in future generations.

Cucurbita Pepo. No further progress has been made during the year in determining the genetics of the soft seeded character in some pepo crosses, due to the poor crop produced during the summer. This character does not seem to behave in a simple Mendelian manner, and the actual behavior has not been determined.

Rutabaga or Cape Turnip. At the request of growers in Bristol County, a large number of strains and varieties of rutabaga were collected for trial. Several of these were growers' strains obtained on the Cape and in Bristol County. It was determined that the growers' strains of white rutabaga were superior to any obtainable from seedsmen. This was probably due to the lack of importance of white rutabaga to the seedsmen. There is a lack of uniformity in all the strains of white rutabaga. Several seedsmen have fine strains of yellow rutabaga.

Greenhouse Cucumber. Powdery mildew on cucumbers is a serious disease of the greenhouse crop and a disease-resistant strain would be very desirable. In cooperation with Dr. Guba, Field Station Pathologist, 265 strains and varieties of Cucumis, imported and collected by the Bureau of Foreign Plant Introduction, were tested for resistance to mildew. No *Cucumis sativus* were found resistant although several *Cucumis melo* var. *Flexuosus* were resistant to cucumber mildew.

Blue Hubbard Squash. Very little progress has been made this season toward producing a good strain of Blue Hubbard Squash, due to the failure of most of the self-pollinated blossoms to develop. This lack of fertilization of the blossoms was due to the hot, dry weather that prevailed during pollination. However, it was determined from the yield data that growers' strain A is almost twice as good in a cross as growers' strain B. This elimination of many hybrids will permit a more concentrated effort on the desirable strains.

DEPARTMENT OF POMOLOGY

R. A. Van Meter in Charge

The winter of 1936-37 was remarkably mild. The records of the Station show that the lowest minimum of the winter, 5° F., occurred on November 25 and 28. Winters with no subzero temperatures are very infrequent and the occurrence of the winter minimum in November is unprecedented. Peach buds came through the winter with little injury and the crop was good.

The summer was also in contrast with recent years because of abundant and well-distributed rainfall. Apple scab was more prevalent than for many years, but some fruit growers were able to combat it successfully and harvested clean crops. Brown rot of stone fruits was prevalent and strawberries rotted rather badly.

More than half the bearing apple trees in the experimental orchards were removed, having served their purpose in our investigations. The trees remaining bore a somewhat smaller crop than last year.

The Influence of Various Clonal Rootstocks on Apple Varieties. (J. K. Shaw and L. Southwick.) Experiments in propagation were continued. Most of the Malling stocks grew well from root cuttings taken from two-year-old nursery trees but there seemed to be differences with the different stocks. All attempts to root hardwood cuttings with and without treatments with different hormones failed. Budding these stocks was more successful than in the previous two years, due largely to more favorable moisture conditions.

The plants in the stock bed were all laid down horizontally and the new shoots hilled up with better success in producing rooted shoots. Stocks grown on short pieces of seedling nurse roots rooted well with most stocks.

Plans were made and trees budded for setting an orchard of certain varieties on certain Malling stocks to replace the old Stock and Scion Orchard which was removed in the spring of 1937.

In relation to this project about 2,000 trees budded on Malling stocks were planted in cooperation with twenty different commercial growers over the State.

The South Amherst orchard made little growth even with adequate summer rainfall and fertilization with manure. It is planned to make a study of the reason for the small growth of these trees.

The Malling stock orchard of McIntosh and Wealthy at the Station produced a good crop. There is a certain area where there are many trees making poor growth. Some of these were treated by injecting various combinations of fertilizer elements (including certain "minor elements") into the soil around the tree. No results were observed but this work will be continued.

Studies of the fruit suggest that the rootstock influences both size and shape of the fruit. They also show that the progressive decrease in size from year to year is greater with trees on the dwarfing stocks, especially on Malling IV. Trees on this stock seem to grow and mature very rapidly and may be expected to reach old age earlier than those on the usual stocks.

Tree Characters of Fruit Varieties. (J. K. Shaw and A. P. French.) A trip among nurseries, similar to the one made last year, gave further opportunity for study on this project. Special attention was given to sweet cherries and peaches. It is believed that the varieties of cherries commonly met with can be identified with certainty. Leaf serrations are of little value, but leaf shape, folding, and light reflections of the leaf are valuable. Considerable progress was made with peach varieties and plans are being made to grow a collection of varieties

commonly found in nurseries for closer observation. These will be budded on red-leaved stock thus making it easy to avoid confusion from stock buds growing into trees. Another attempt to grow a more successful cherry nursery is planned.

Certification work under the auspices of the Massachusetts Fruit Growers Association was continued on the relatively small scale of the past few years. It seems that the simpler and less expensive practice of inspection where no tags are attached to individual trees is thought to be adequate by most nurserymen and fruit growers.

The Genetic Composition of Peaches. (J. S. Bailey and A. P. French.) As a result of the breeding work in 1936, there are in the nursery at the present time 373 selfed Oriole seedlings. This number represents about 50 percent of the seeds planted. Because rats destroyed part of the seed, it was not possible to get the exact percentage of germination. There are also in the nursery 250 selfed Elberta seedlings and a few cross-bred seedlings.

Since the winter of 1936-37 was a mild one, the bloom in the spring of 1937 was heavy and additional breeding work was done. Marigold and Oriole were again selfed to attempt to increase the population from these early varieties.

Another attempt was made to grow Marigold pits on a nutrient agar medium in bottles. This was more successful than in 1936, but still the percentage of germination was too small to be at all satisfactory. Pits from this variety were taken from the peaches as soon as they ripened, and immediately stratified in sand, to see if this treatment would induce germination.

The 1937 crop was good, but due to the wet season the fruit of many of the seedlings rotted before it was ripe and for this reason it was impossible to get observations on a number of seedlings. Additional evidence was obtained that there is a linkage between the free and the melting flesh characters in the Belle of Georgia variety and that there is crossing over to the extent of about 6 to 8 percent. Information was also obtained which points to a simplification of the confused situation which now exists in regard to the classification of the free-stone, semi-cling, and clingstone groups of peaches.

Comparison of Cultivation and Sod in a Bearing Orchard. (J. K. Shaw.) The Baldwin trees were removed thus leaving more space for the McIntosh trees. The crop was light and most of the trees are showing an increasing tendency toward biennial bearing. The same treatment as in recent years was continued but some changes are planned for next year. The two plots having a complete fertilizer continue to yield well; the cultivated plot with no fertilizer yielded better than in previous years. Evidently nitrogen alone is not a satisfactory fertilizer in this orchard, but how far these results can be applied to orchards on other soils is uncertain.

Comparison of Clover Sod and Grass in a Sod Mulch Orchard. (J. K. Shaw.) As recorded last year this project has been changed to a comparison of sod with a sawdust mulch, both with a complete fertilizer. The sawdust was spread about three or four inches thick but failed to check the growth of grass very much. No injurious effect on the trees was noted. Further observations are needed before any conclusions can be drawn.

Comparison of Cultivation and Heavy Mulching for Apples. (J. K. Shaw.) This project was continued without change. The crop was small but both McIntosh and Wealthy continue to do better on the mulched plots. The practice of mulching continues to increase in favor among fruit growers. The limiting factor is the cost and scarcity of suitable mulching material.

The Effects of Fertilizer Limitation on Fruit Plants. (J. K. Shaw.) This project was continued as in previous years. A subsoil plow was drawn through between the plots to minimize the danger of root trespass. Determinations of potash content of the leaf petioles by the Thornton test were made. These agree generally with those made in previous years. The growth of the tree is negatively correlated with the amount of leaf burn and notes of this were taken. Leaf burn is not closely correlated with potash deficiency.

The trees bore a scattering crop. The bearing trees showed little relationship with fertilizer treatment. Because of the narrow plots and crowded condition of the trees it will be necessary to remove these trees in the near future.

Effect of Potash and Lime on Apple Trees. (J. K. Shaw.) No new tendencies appeared in this orchard but the trees, especially on the plots without nitrogen, are not performing well. The variety Wealthy requires better cultural conditions and it is planned to introduce a system of partial cultivation in place of sod culture.

Study of Varieties of Fruits. (J. K. Shaw and staff.)

Apples. There is little to add to the comment made in recent reports concerning new varieties. There are about 75 under test.

Haralson fruited for the first time and proved to be a large, attractive apple except for rather dull red color.

Kendall has not fruited here, but specimens from a southern Vermont orchard proved disappointing in flavor. Further observations are necesssary before its quality when grown in New England can be compared with its quality when grown at its place of origin.

The red sports continue to receive increasing attention and are found in greater numbers in nurseries each year. It is apparent that not all red sports of a given variety are alike. As they cannot be told apart by the nursery trees there is likely to be confusion in buying trees. The Red Spy and Red Gravenstein commonly sold by nurseries seem to be of the strains sent out by the New York Fruit Testing Association. There are various red strains of Delicious under propagation and it is important that the grower be sure just what strain he is getting.

The "Yellow Delicious" offered by many nurseries cannot be distinguished in the nursery from Golden Delicious.

Pears. Cayuga seems promising as a larger pear of the Seckel type.

Plums. Imperial Epineuse from Geneva produced the first real crop this year. It is yellowish-green in color and not particularly attractive but is of excellent quality. It promises to be a desirable variety for the home garden and local trade.

Peaches. The peach variety orchard produced a good crop and observations confirmed previous reports on the varieties grown. Twelve varieties of apricots from South Dakota were put out for trial.

Grapes. Erie, from its performance this past season, promises to be a desirable early blue grape. It ripens about the third week in August, has large berries with an attractive bunch, and is very good in quality.

Fredonia is a desirable substitute for Moore's Early in that it ripens at about the same time and is superior in quality, type of bunch, and production.

Raspberries. Marcy appears superior to Taylor in quality and production.

Indian Summer again failed to mature the fall crop. Many numbered seedlings have been discarded because they appeared to be worthless. Those which show any promise have been retained for further observation.

Sodus, the new purple raspberry from Geneva, appears to be superior to any variety of this type grown here.

Strawberries. Catskill was one of the outstanding varieties in the plantation this year. It surpassed Howard 17 in production. The berries were large and were firmer and more attractive in the basket than Howard 17. It appears to be the best variety for this section that has been produced at the Geneva Station.

Dorsett, while superior in quality, size, and attractiveness, has some faults that limit its value as a commercial sort. It is not a heavy producer even when grown under the spaced row system and the late berries tend to be poorly formed. It is an excellent variety for the home garden.

Fairfax is similar to Dorsett in many respects. It is less tart and retains size better but because of its dark color is less attractive. It is a good variety for the home garden when a mild berry is particularly desired.

Thompson Late is unquestionably the latest variety ever grown here, but the plants and fruit are exceedingly unattractive. The leaves of the plants tend to roll up and the berries are rough and light in color. The quality is only fair and production is good but not exceptional.

Chesapeake is an old variety but is mentioned here because it is a late berry that is attractive and has good quality. In these two respects it surpassed any late variety that has been grown here. Production is relatively low however.

Pathfinder (New Jersey 35) is a new variety from New Jersey that ripens in early midseason, is medium or above in production, and is very attractive. However, the quality is only fair and the berries tend to be somewhat soft. Further observations on this variety are necessary in order to determine its real worth for Massachusetts conditions.

Fruit Bud Formation in the Strawberry. (R. A. Van Meter.) To study further the effects on fruiting of CO_2 in the soil and to provide a check on the results of 1935, eight plots of 87 parent plants each were established in 1936. To eliminate complications arising from a varying stand of plants each parent plant was allowed to form two runner plants only. Four plots were fertilized with two pounds each of dextrose on August 3, August 15, and September 3. The other four plots were not treated. The crowns of all the plants were damaged by cold in the autumn of 1936.

These plots were harvested in 1937. The treatments resulted in a slight reduction in yield.

To study the possibility that winter injury might be responsible for continued failure to get a response to differential soil treatments, 24 plots were established in the spring of 1937. The following treatments were made, each replicated four times.

1.—No mulch.
2.—Light mulch applied early.
3.—Light mulch applied late.
4.—Light mulch applied early, more mulch applied later.
5.—Heavy mulch applied early.
6.—Heavy mulch applied late.

Bud Mutations. (J. K. Shaw and W. H. Thies.) The observations on the scattering crop are but a repetition of those made last year. Some of the grafts supposed to be from mutating trees or branches of trees differ little, if at all, from the original variety, but two or three are distinct sports.

Storage of Apples Under Various Conditions. (O. C. Roberts cooperating with Agricultural Engineering Department.) For several years this Station has investigated the problem of McIntosh storage. Previous results have indicated that

McIntosh that are held for a short period at 45° F. after harvest before being cooled to 32° F. develop a better flavor than similar apples held at 32° F. continuously, and will hold in marketable condition until January 1 or later. A repetition of this work during the past season confirms the results of previous years.

Tests of Various Spray Materials. (O. C. Roberts cooperating with Departments of Entomology and Botany.) This project of testing spray materials was continued during the past season. Each year a multitude of new materials appear on the market together with various recommendations, chiefly by manufacturers, for the mixing and combining of established preparations. These numerous possibilities tend to confuse rather than assist the fruit grower. Hence, the purpose of these spray tests each year is an attempt to measure the real worth of those materials and combinations which appear to merit consideration. A discussion of the materials tested this year together with results obtained may be found in the report of the Entomology Department.

Elimination of Arsenic and Lead Residues from Apples. (O. C. Roberts cooperating with Entomology Department and Fertilizer Control Service.) Since 1925 when the Federal Government placed a limit of tolerance for arsenic on apples, the fruit-growing industry has been concerned with the elimination of residue. Results of previous work at this Station have shown that adherence to the recommended spray schedule for Massachusetts will produce fruit that is practically free from insect and disease blemishes and at the same time is within the limits of tolerance of .018 gr. per pound for lead and .01 gr. As_2O_3 per pound for arsenic. With the possible reduction of the tolerance for lead it is conceivable that the present spray schedule might leave deposits of lead in excess of the lower tolerance. With this possibility in mind experiments on methods of removal were begun in 1934. This work has been continued this year with McIntosh and Cortland apples which received a complete spray schedule. Several bushels of each variety were wiped on a commercial wiper and similar lots of each were washed in a one percent solution of hydrochloric acid. Samples were taken from each lot before and after treatment and were analyzed for lead and arsenic residues by the Fertilizer Control Service. The results of the analyses are shown in the following table.

	McINTOSH		CORTLAND	
	Lead	Arsenic (As_2O_3)	Lead	Arsenic (As_2O_3)
Untreated...	.009	.0033	.019	.0065
Wiped.....	.011	.0044	.021	.01144
Washed.....	.003	.002	.002	.00077

These results are consistent with those obtained in previous work at this Station, and show that wiping tends to increase the arsenic and lead residues rather than decrease them and that washing in a one percent solution of hydrochloric acid is an effective method of reducing these residues well within the limits of tolerance.

The Nutrition of the Highbush Blueberry, Especially in Relation to Soil Reaction. (J. S. Bailey.) Blueberry Plot D which is to be used in connection with the nutrition work, bore its first crop in 1937. The experiments started in 1936 to test various chemicals as acidifiers for blueberry soil were continued in 1937. On May 21 one gram of nitrate of soda was added to each plant. This fertilizer greatly increased the growth of the plants but at the end of the season the relative

position of the various treatments was essentially the same as in 1936. For this reason, no change is necessary in the statements made in 1936 concerning the various treatments.

The study to determine the cause and the cure for chlorosis of cultivated blueberries, which was started in 1935, was continued in 1937. A progress report covering this work will appear in the *Proceedings of the American Society for Horticultural Science* for 1937.

Blueberry Culture. (J. S. Bailey.) The study of the self-pollination of the cultivated blueberry was continued in 1937. A report covering the results of this work from 1935 to 1937 will appear in the *Proceedings of the American Society for Horticultural Science* for 1937. Experiments were started to determine the effect of Gamma (Indole-3)-n-butyric acid on the rooting of blueberry cuttings. This material was tried on dormant cuttings at concentrations of five, ten, and twenty milligrams per hundred cubic centimeters of water for twelve, twenty-four, and forty-eight hours at each concentration. Dormant cuttings showed little or no response when treated for twelve or twenty-four hours at any of the three concentrations. Treated for forty-eight hours, all three concentrations appeared to be toxic. Green wood cuttings taken in July just as secondary growth started were treated for twelve and twenty-four hours with solutions and concentrations of five and ten milligrams per hundred cubic centimeters of water. There appeared to be a slight stimulation of rooting in those cuttings treated for twenty-four hours at a concentration of ten milligrams per hundred cubic centimeters.

For several years blueberry Plot A has been handled under a mulch system, using sawdust and shavings for the mulch. There has never been any indication of mice working in this mulch. In the summer of 1937, Blueberry Plot B was mulched with a heavy coating of waste hay. In October there was ample evidence of a heavy infestation of mice, although this plot is surrounded by plowed land on which a cover crop of buckwheat was grown. This difference in the preference of mice for the two types of mulch may be an important consideration in the mulching of blueberry fields in sections where mice are prevalent.

A row of Jersey plants in Plot C bore their first crop this year. This variety looks very promising. The berries were large, very attractive, firm, and of excellent flavor when well ripened This variety seems to tolerate a drier soil than most other varieties. The variety Pioneer was rather disappointing in its performance in 1937 because the berries tended to drop off considerably in size at the end of the season. The variety Cabot apparently needs picking oftener than other varieties since it has much more of a tendency to drop as soon as ripe.

Premature Dropping of the McIntosh Apple. (L. Southwick.) Work on this project was continued in the light of certain conclusions derived from last year's data. It was found that a study of the total population (entire crop) of a tree gave more significant results than a study of any one particular section of that tree. This possibly is explained by variations between different branches.

This past summer variable fertilizer treatments including direct limb injections were initiated. Also a precise dropping record of numbered app'es on three McIntosh trees was kept. Percentages of dropped fruit will be computed, as in years past, for each McIntosh tree in the Station Orchards. The year 1937 will go down as one with heavy drop.

The most significant finding to date is the correlation of time of dropping with fruit seed number. As a general rule, the early drops contain fewer fully developed seeds than those apples that hold on. This seems to hold true for short time durations, even a few days. There is also inconclusive evidence pointing to the prob-

ability that fruit shape may have an influence. Undoubtedly many other factors are directly or indirectly associated with pre-harvest dropping of the McIntosh apple. It is hoped that this investigation will eventually produce concrete findings some of which may be applicable to a practical approach to the problem.

Coloring Apples. (R. A. Van Meter, O. C. Roberts, and G. G. Smith.) The fact that sunlight is an essential factor in the production of red color on apples has long been recognized. Consequently apples that are shaded by dense foliage will not color. A well-colored apple is worth at least twice as much as a green one. Therefore, if a practical method of exposing green apples to sunlight after they are harvested could be developed, a higher percentage of the crop would sell at top price.

That apples exposed to direct sunlight soon after harvesting will develop additional red color is an accepted fact. However, apples thus exposed frequently develop a severe case of sunburn. How, then, may the benefits of coloring be obtained without the development of sunburn? In an attempt to find an answer to this question four bushels each of green and partly colored McIntosh were selected. One bushel from each lot spread out in a single layer was exposed under one thickness of cheesecloth, another bushel under two layers of cheesecloth, a third bushel was exposed to direct sunlight, and the fourth bushel was placed in 32° F. storage for future comparison.

Due to cloudy weather the apples were in the coloring frame for six days (September 9 to 16). During this period there were 30 hours of bright sunshine with an average mean temperature of 60°. As a result of this exposure the green apples acquired at least 50 percent color and some specimens which were turned during the period of exposure showed as much as 90 percent color. The increase in color in the case of apples that were partly colored before exposure was marked but not as pronounced as in the case of the green apples.

As the apples were removed from the coloring frame they were placed immediately into 32° F. storage. Examination of these apples on December 31 indicates that the coloring process did not materially impair their keeping quality. Apples that were not covered with cheesecloth developed a sunscald on practically every apple. Shading the apples with one layer of cheesecloth eliminated sunscald on 95 percent of the specimens. Shading with two layers of cheesecloth eliminated sunscald completely. Apples shaded with two layers of cloth colored as well as those shaded with one layer.

DEPARTMENT OF POULTRY HUSBANDRY

J. C. Graham in Charge

Broodiness in Poultry. (F. A. Hays.) The three major objectives in this project are: (1) To secure adequate data on the inheritance of degrees of broodiness, (2) to study the problem of deferred broodiness, (3) to develop a genetically non-broody line of Rhode Island Reds.

To produce the generation hatched in 1936, one aged tested male was mated to nine females, some tested and some not tested. This mating was unsuccessful because of the sexual regression of the male. A second pen of eight females was mated to a yearling male. From this mating three families of daughters consisting of 27 individuals were housed for a trapnest record. Only one family of 7 daughters showed complete absence of broodiness for the first laying year. A second family of 10 daughters showed 2 broody and 8 non-broody. The third family had

3 broody to 1 non-broody. These limited data show typical results from mating individuals that are genetically untested for broody genes.

The present generation hatched in 1937 was sired by two yearling males with a non-broody heritage, mated to yearling, two-year-old, and three-year-old hens with non-broody records. This generation of 100 daughters will furnish data on the question of deferred broodiness.

Breeding Poultry for Egg Production. (F. A. Hays and Ruby Sanborn.) Selective breeding has been carried on in an effort to increase the number of eggs laid and at the same time to improve the flock in body weight, in rate of chick feathering, and in plumage color and to eliminate such undesirable characters as small egg size, light egg-shell color, mottled ear lobes and lopped comb. Another major objective has been to reduce variability in annual egg production.

The last generation of birds shows the general progress that has been made in the experiment. Broodiness stood at the low figure of 4.35 percent of the birds. The mean annual egg production was 234.5. The mean length of winter pause has fallen to 10 days, winter intensity has not changed, persistency has increased from 337 to 351 days — all in comparison with the previous flock. The mortality for a full year in the laying house without culling was 15.95 percent.

In order to test the mode of inheritance of a number of characters being studied, crosses with outside stocks are constantly being made. The results obtained in this project, however, are measured on the pure strain of Rhode Island Reds that has been carried since 1913.

Statistical Study of Heredity in Rhode Island Reds. (F. A. Hays and Ruby Sanborn.) Data have been tabulated and prepared on eight years' work on the inheritance of egg size and external shell characters and published as Station Bulletin 344. Data on body weight in relation to egg production characters, factors affecting fertility, and the relation of time interval between clutches and fecundity are in preparation for publication.

A Genetic Study of Rhode Island Red Color. (F. A. Hays.) Some progress has been made in developing an exhibition line for color alone and another line with exhibition quality combined with the characters essential to high fecundity. Progress is hampered by the necessity of working with small units.

Rate of Feathering in Rhode Island Reds. (F. A. Hays.) The generation hatched in 1937 showed 37 percent of the males to be early feathered in the rapid feathering line and none to be early feathering in the slow feathered line. The wide family variability in the early feathered line indicates that female breeders should be carefully selected from those families with the highest percentage of early feathered males in order to make rapid progress in fixing early feathering in the flock. No relation between rate of feathering and fecundity characters has been discovered thus far.

Breeding for Low Mortality. (F. A. Hays.) Two lines are being developed with respect to mortality rate in the laying houses. The sole basis used in selecting is the mortality rate during the first year of laying. The high and low mortality lines have been carried through three complete generations. Mortality rates in the high line were 40.0 percent, 24.2 percent, and 16.7 percent. In the low line the rates through three generations were 39.5 percent, 0 percent, and 10.3 percent. Annual egg production of the survivors was higher in the low line than in the high line for two generations and equal in the two lines in the third generation. Selective breeding appears to have produced a significant difference in the mortality rates of the two lines.

Time of Emergence of Chicks from the Shell as a Factor in Poultry Breeding. (F. A. Hays.) Records were obtained this year on the time of emergence of 1982 chicks from the shell. Observations were made at eight-hour intervals beginning with the end of the twentieth day. Only one chick emerged at the end of the twentieth day and a relatively small percentage during the first third of the twenty-first day. The greatest proportion of the chicks emerged during the last third of the twenty-first day and the first third of the twenty-second day. A few chicks did not emerge until the last third of the twenty-second day.

These preliminary data show no significant relation between time of emergence and sex, mortality rate, or body weight of pullets at 170 days of age.

Relation of Plumage Color to Sex in Rhode Island Red Chicks. (F.A. Hays.) A total of 3200 pedigreed Rhode Island Red chicks has been described for brown and black pigment spots or stripes on head, neck and back. The value of such pigment areas as an indicator of sex at hatching has not been determined. The relation of this early pigmentation to adult plumage color is being studied.

SEED CONTROL SERVICE

Philip H. Smith in Charge

Seed Inspection. (F. A. McLaughlin and Jessie L. Anderson.) From October 1, 1936 to December 1, 1937* the Seed Laboratory received and worked 2220 samples of seed, of which 874 were collected by the State Commissioner of Agriculture, 1173 were sent in by seedsmen and farmers, and 173 by the American Can Co. for cooperative research.

Classification of these samples with the total number of tests involved is shown in the following summary. It will be noted that the total number of tests required for the 2220 samples was 3080; 769 for purity and 2311 for germination:

Samples		Purity	Germination
421	Field Crops for Purity and Germination	421	421
89	Field Crops for Germination		89
94	Lawn mixtures for Purity only	94	
151	Lawn mixtures for Purity, Germinations involving 439 ingredients	151	439
1228	Vegetable seeds for Germination		1228
103	Flower seeds for Purity	103	
90	Flower seeds for Germination		90
20	Tree seeds for Germination		20
24	Tobacco seeds for Germination		24
2220		769	2311

Field tests to determine trueness to type were conducted in cooperation with the Departments of Vegetable Gardening and Floriculture, the former testing 168 samples of Vegetable seeds and the latter 103 samples of Flower seeds. All samples for these tests were collected and submitted by the State Commissioner of Agriculture.

*Laboratory year formerly from October 1 to October 1—changed to correspond with fiscal year beginning December 1.

Miscellaneous Work. (F. A. McLaughlin and Jessie L. Anderson.) The Seed Laboratory received 1115.4 pounds of unclean onion seed from Connecticut Valley Farmers, which were returned as 671.3 pounds of clean seed.

Eighty-three samples of corn, oats, barley, and wheat, purchased by various state institutions, were examined for conformity to grade purchased; and twenty-four samples of ground cattle and poultry feed collected by inspectors or sent in by dealers and farmers were examined microscopically.

DEPARTMENT OF VETERINARY SCIENCE

J. B. Lentz in Charge

Poultry Disease Control Service. (H. Van Roekel, K. L. Bullis, O. S. Flint, and M. K. Clarke.)

1. *Pullorum Disease Eradication.* During the 1936-37 testing season, a total of 311 flocks (including four flocks of poultry other than chickens) representing 463,095 samples (including 1,333 from fowl other than chickens) was tested. Among the samples submitted from fowl other than chickens 488 were tested with a paratyphoid antigen. Blood samples were submitted from chicken flocks in 11 counties. Norfolk, Worcester, and Middlesex Counties led in the number of tests. The testing results showed increases in tested flocks (55), tested birds (118,860), tests (117,681), and non-reacting flocks (51) over the previous season. The average percentage of positive tests among the total samples tested was 0.37. In only two counties the percentage of positive tests exceeded 0.5 of 1 percent. Pullorum infection was detected in six flocks which were negative to the macroscopic tube agglutination test the previous year or years. In four of these flocks no explanation for the origin for the infection was obtained.

The results show that Massachusetts poultrymen are making progress in pullorum disease eradication and in maintaining their flocks free from the disease. The results show that a total of 281 non-reacting flocks, representing 424,431 birds, were detected. The number of birds in the non-reacting flocks represented 94.6 percent of the total birds tested. The number of birds in the 100 percent tested flocks was 378,563, which represented 84.4 percent of all birds tested. A total of 162 flocks tested for three or more consecutive years, representing 326,435 birds, revealed less than 0.1 of 1 percent infection.

During the past year a turkey flock infected with pullorum disease was subjected to agglutination tests at four-week intervals. Four tests were applied and significant reactors were detected only on the first test. *S. pullorum* was isolated from reactors detected on the first test. No evidence of pullorum infection has been obtained in progeny raised from the tested breeders.

The pullorum disease testing results show that Massachusetts flock owners have available within this State known pullorum clean stock from which replacements can be purchased to establish additional pullorum clean flocks.

2. *Diagnostic Service.* The laboratory received 472 consignments of specimens for examination. Personal delivery of specimens was made 288 times. The classification of 2,264 specimens examined is as follows: 1,944 chickens, 184 turkeys, 72 pheasants, 16 fecal samples, 10 ruffed grouse, 7 bovine, 6 ducks, 5 rabbits, 4 foxes, 4 quail, 4 sheep, 3 deer, and 1 each of canine, hog, horse, mink, and pigeon. Tumors, infectious bronchitis, pullorum disease, fowl paralysis, and coccidiosis were the diseases encountered most frequently. Fowl cholera and fowl

typhoid were detected on more premises than the previous year. Fowl cholera was identified on eight premises of which six represented new foci of infection, whereas fowl typhoid was diagnosed on four premises all of which represented new foci. Fowl typhoid in turkeys was encountered once. Paratyphoid infection was diagnosed once in chickens and three times in turkeys. From one turkey flock 51 dead embryos were cultured and no paratyphoid was isolated. One case of avian tuberculosis was noted.

3. *Flock Mortality Studies.* Morbid and dead specimens were necropsied from two flocks.

Flock A. Among 765 pullets placed in the laying houses in September, 1936, the mortality was 122 birds (15.95 percent) of which 106 (86.88 percent) were submitted to the laboratory during the first laying year or from September, 1936, to October, 1937. As in former years the peak mortality in this flock was reached from March to July, inclusive, when 62 birds (58.49 percent) were received. Of the 106 birds examined, two were decomposed and no diagnosis was made in 14 (13.21 percent). Twenty-four disease conditions were observed among the specimens submitted. Reproductive disorders 22 (18.33 percent), kidney disorders 21 (17.50 percent), cannibalism 14 (11.66 percent), and tumors 13 (10.83 percent) represented 58.33 percent of the total diagnoses.

Flock B. On October 1, 1936, the flock consisted of 694 pullets. Examinations were started November 1, covering a 13-months period to December 1, 1937, and including 308 birds or a mortality of 44.38 percent. The season of peak mortality was longer than in Flock A, extending from February through August, and included 221 birds (71.75 percent). Of the specimens submitted, eight were decomposed and six were recorded as "no diagnosis". A total of 39 disease conditions was observed among the specimens. Tumors 80 (21.05 percent), fowl paralysis 59 (15.53 percent), kidney disorders 55 (14.47 percent), reproductive disorders 36 (9.47 percent), cannibalism 14 (3.68 percent), gizzard necrosis 14 (3.68 percent), and enterohepatitis 12 (3.16 percent) accounted for 71.05 percent of the total diagnoses. Fowl paralysis and tumors showed a greater incidence in this flock than is usual among birds of this age. The incidence of fowl paralysis continued high until May when the birds were over one year of age. The high incidence of tumors began in March when the birds were nearly one year of age and continued during the period of observation.

4. *Erysipelas Outbreaks in Turkeys.* Disease outbreaks due to *Erysipelothrix rhusiopathiae* were observed in three widely separated turkey flocks at approximately the same time of the year. This disease among turkeys has been reported previously only twice in this country. Affected birds may exhibit very pronounced and striking pathologic changes. Erysipelas infection in adult turkey flocks may cause serious losses in the form of mortality, retardation in growth, and less profitable marketing of carcasses for food consumption. The results of the field and laboratory studies have been submitted for publication in the *Journal of the American Veterinary Medical Association.*

5. *"Epidemic Tremor" in Chicks.* During the past year "epidemic tremor" investigations have been continued. Chicks hatched at the laboratory from breeding stock which survived the disease did not exhibit symptoms of "epidemic tremor". The disease was transmitted from spontaneous field cases to experimental chicks by means of intracerebral inoculations with saline–brain suspension. The disease-producing agent has been maintained in chicks through 34 serial passages. Filtration experiments have demonstrated that the cause of the disease is a filtrable agent. The disease was not transmitted from inoculated infected chicks to uninoculated chicks through cohabitation. Chicks hatched

from eggs inoculated with saline–brain suspensions prepared from affected chicks developed the disease. Birds eight to ten weeks old, inoculated intracerebrally with saline-brain suspension prepared from affected chicks, developed the disease. This disease is of economic importance to the chick industry and studies are being continued to determine the source or reservoir of the disease-producing agent in order to develop possible methods of control and prevention.

6. *Feeding of Sumac Fruit to Chickens.* Since wild birds utilize sumac fruit as one source of feed, an effort was made to determine the palatability and toxicity of this fruit when fed at will and by means of force feeding. Four chickens, approximately six months old, and the fruit of the staghorn sumac (*Rhus typhina*) were used in the feeding trials. Force feeding of 16 grams of ground sumac per day for five days did not appear to have a toxic effect. Using a mixture of ground sumac fruit and laying mash and permitting the birds to eat at will, resulted in little or no feed being consumed, which suggested that the sumac was not palatable for birds employed in this experiment. This investigation was conducted in cooperation with the Department of Forestry.

7. *Viability of S. pullorum.* Viability studies, which are still in progress, have shown that *S. pullorum* has remained alive in a dry piece of cloth for a period of five years.

8. *Farm Department Brucellosis Control and Eradication.* The laboratory cooperated in this work by testing 878 bovine blood samples for Bang's disease and 52 porcine blood samples for Brucella infection. The standard tube agglutination method was used.

Studies of Neoplastic and Neoplastic-like Diseases. (Carl Olson, Jr.) Various investigations of fowl leukosis, fowl paralysis, lymphocytoma and other neoplastic-like diseases of the domestic chicken are under way. One object of these researches is to seek the similarities or dissimilarities of these diseases from a biochemical point of view by means of a study of the tissue respiration, which it is hoped may be of considerable value in the understanding of these disease processes. Another sphere of activity has to do with a study of the relative incidence of various types of neoplasia among chickens selected from various sources.

Two strains of transmissible fowl leukosis are being maintained and studied. One of these strains originated with material obtained from Dr. J. Furth, Department of Pathology, Cornell University Medical College, New York, N. Y.

The other strain of transmissible fowl leukosis was derived from a poultry flock in Massachusetts where several instances of the disease had occurred. This flock was composed of 47 chickens, among which there were no losses from disease until they were 110 days of age. During the succeeding two months seven birds became ill and died with either fowl leukosis or neoplastic disease. Two of these instances of fowl leukosis were demonstrated to be transmissible to experimental chickens and the transmissible agent has as yet produced only transmissible fowl leukosis. Two cases of neoplastic disease with tumors of the visceral organs have been used as a source of material for the inoculation of experimental animals. One of these tumors has been transplanted into a third generation of the experimental chickens, which procedure has as yet induced no instances of fowl leukosis. The transmissible strains obtained from this flock must be carried through many more experimental chickens before it is possible to tell whether only one or more than one disease-producing agent was responsible for the outbreak of disease noted in the flock selected for study.

WALTHAM FIELD STATION
(Waltham, Massachusetts)

Ray M. Koon in Charge

For reports on approved projects conducted at this Station, in addition to those listed under this caption, see reports of the Departments of Botany, Entomology, Floriculture, Horticulture, and Olericulture.

Consultation and Information Service. The strategic location of the Waltham Field Station makes it possible for a majority of the intensive farmers of the State to reach this Station within an hour by automobile. As most growers realize that a personal call is much better than a letter or telephone call, they come to the Field Station with their problems even during their busiest season. This makes it necessary for the research men to give a considerable part of their time for consultation. Professor Dempsey, appointed two years ago to relieve the research men of this growing activity, has not even been able to take care of the increase. Fortunately, the addition of Professor Graves to the staff as nursery-culturist has spread the work somewhat. It is hoped that the proposed addition of a service in turf-culture will relieve the research men of a number of inquiries concerning turf diseases and insects, and grass soil analyses.

Groups meeting at the Field Station during the year include the Boston Market Gardeners Association, the New England Greenkeepers Association, Rural Electrification Agents of the New England Power Company, New England Carnation Growers Association, the New England Plant Pathologists, the Boston Gardeners and Florists Club, and the Boston Branch of the National Gardeners Association.

Commercial growers and others seeking horticultural information made over 4000 telephone calls. Visitors to the number of 4204 came to the Field Station during 1937. The ornamental display and test gardens attracted 3156 visitors during the growing season.

Field Day. The Nineteenth Annual Field Day was held on August 4 with an attendance of over 1200 The following vegetable contests were held: Celery, Bunched Carrot, Pepper, Trellis Tomato, Bunched Beet, and Summer Squash. Although it seems impossible to increase the number of entries in these contests, the quality of the vegetables entered is second to none.

Soil Testing Service. (Paul W. Dempsey, Harold E. White, Robert E. Young.) The total number of samples of soil submitted for testing was nearly double that of last year.

Summary of Soil Tests

Greenhouse:	
Flowers	657
Vegetable	237
Market Gardeners	785
Miscellaneous*	2397
	4076

*Includes flower gardens, vegetable gardens, lawns, golf courses, landscape gardeners, Metropolitan District Commission, and Highway Beautification.

Seedsmen's Variety Trial Days. (Paul W. Dempsey.) The New York Experiment Station and Cornell University have for a number of years held special meetings for those interested in vegetable varieties. As these meetings are now

held every two years, an invitation to look over the variety trials at Amherst and Waltham this year was accepted by over 70 seedsmen and Experiment Station workers. The interest shown would seem to indicate that such a meeting might well be repeated in Massachusetts every four years.

PUBLICATIONS

Bulletins

339 Annual Report for the Fiscal Year Ending November 30, 1936. 100 pp. March, 1937.

The main purpose of this report is to provide an opportunity for presenting in published form, recent results from experimentation in fields or on projects where progress has not been such as to justify the general and definite conclusions necessary to meet the requirements of bulletin or journal.

340 Historical Trend in Massachusetts Industries, 1837-1933. By David Rozman and Ruth E. Sherburne. 31 pp. January, 1938.

In Massachusetts as in many other states, there have occurred over a period of years shifts in population and in the distribution of industries between individual cities and towns of various sizes. This publication presents a graphic summary of the changes in population, number of industrial employees, and number of industrial establishments during the last hundred years, for those cities and towns of the Commonwealth where the historical data are available.

341 Vacuum–Pressure Relationships in Glass Canning Jars. By C. R. Fellers, A. S. Levine, and W. A. Maclinn. 20 pp. April, 1937.

The present method of canning foods in the all-glass type of fruit jar has several disadvantages, some of which are overcome by a slight change in method of processing. As a result of a two-year investigation of the vacuums and internal pressures in all-glass canning jars during heat processing and of practical cooperative experience involving over 16,500 all-glass jars, 50 canned foods, and 60 home canners, it is considered advisable to recommend sealing the jar by tightening the wire bail previous to thermal treatment (processing). This method decreases markedly the losses of liquid from jars during processing, improves the appearance of the contents, saves time, obviates the necessity of handling the hot jars after processing, and has no effect on either breakage or spoilage.

342 Facts, Fads and Frauds in Nutrition. By Helen S. Mitchell and Gladys M. Cook. 31 pp. April, 1937. (Reprinted in November.)

Present-day food advertisements make a tremendous appeal to a nutrition-conscious public which has only a very limited basis for evaluating the merits of the claims made. This bulletin attempts to present in brief and readable form information, decisions and criticisms by recognized authorities concerning nutritional and therapeutic claims in food advertising as well as faulty concepts and notions regarding foods and nutrition, as a guide to the consumer. Sources of reliable information on foods and nutrition are listed.

343 The Dutch Elm Disease — A New Threat to the Elm. By Malcolm A. McKenzie and William B. Becker. 16 pp. May, 1937.

At the present time the Dutch elm disease is not known to occur in Massachusetts. However, the oldest known American infestation of the principal carrier insect of the disease, the smaller European elm bark beetle, was discovered in the vicinity of Boston in 1909. With this known carrier already well established in Massachusetts, the elms of the State would be in grave danger of destruction should the Dutch elm disease be introduced among them. This bulletin describes the disease and its symptoms, as well as how it is spread, and urges the cooperation of everyone in the efforts being made to protect and preserve the elms.

344 Inheritance of Egg Size and Egg Character. By F. A. Hays. 28 pp. July, 1937.

A study of egg size and egg character, covering nine generations of Rhode Island Reds, is summarized in this report. The data furnish more definite information on the inheritance of egg size, egg shape, shell texture, shell porosity, and shell color, thus making it possible to offer some specific recommendations to poultry breeders.

345 Woody Plants for New England Gardens, Parks and Roadsides. By George Graves. 84 pp. August, 1937.

This is an attempt to evaluate hardy woody plant materials and to summarize expert opinions regarding their adaptability for landscape planting in New England. So far as possible the general idea of evaluation without attempt at dogmatic standardization has been followed through. The plants have been considered for their habit, garden aspect, and cultural behavior, and the resulting data brought into a single treatment.

346 Nitrogenous Fertilizers for Growing Tobacco. By A. B. Beaumont and M. E. Snell. 15 pp. October, 1937.

In the many years that tobacco has been grown in the Connecticut Valley, certain fertilizer practices have come into use. This study was undertaken to provide a research basis for those practices which are considered sound. The study included experiments on quantity and form of nitrogen, ratio of organic to inorganic nitrogen, and method of applying fertilizer. The results indicate that a comparatively high rate of application of fertilizer nitrogen is necessary for growing Havana Seed tobacco of high yield and quality, and that no mor than one half and probably as little as one fourth of the nitrogen need come from organic carriers such as cottonseed meal.

Control Bulletins

88 Seventeenth Annual Report on Eradication of Pullorum Disease in Massachusetts. By the Poultry Disease Control Laboratory. 11 pp. June, 1937.

89 Inspection of Commercial Feedstuffs. By Philip H. Smith. 57 pp. November, 1937.

90 Inspection of Commercial Fertilizers. By H. D. Haskins. 48 pp. November, 1937.

91 Inspection of Agricultural Lime Products. By H. D. Haskins. 9 pp. December, 1937.

Meteorological Bulletins

577-588, inclusive. Monthly reports giving daily weather records, together with monthly and annual summaries. By C. I. Gunness. 4 pp. each.

Reports of Investigation in Journals

242 Acid production by the Escherichia-Aerobacter group of bacteria as indicated by dissolved metallic iron. A. V. Syrocki, James E. Fuller and Ralph L. France. Jour. Bact. 33 (2):185-192. 1937.

A preliminary report of a method which it is hoped may be developed as a means of differentiating Escherichia-Aerogenes bacteria, and especially intermediates of the group, on the basis of their acid production from carbohydrates. When employed with pure cultures, the procedure made possible satisfactory differentiation of *E. coli* from *A.aerogenes* and from intermediates of the group, but differentiation of other members of the group from each other was not accomplished.

249 Salmonella infections in chickens. H. Van Roekel and K. L. Bullis. Jour. Amer. Vet. Med. Assoc. 91 (n.s. 44):48-58. 1937.

Pullorum disease is the most widespread of the poultry diseases caused by members of the *Salmonella* genus, and a leading cause of economic loss to the poultry industry. Data presented show that this disease and possibly other Salmonella infections can be eradicated from flocks by the use of the macroscopic agglutination test along with sound eradication measures.

253 Gas content of cranberries and possible relationship of respiratory activity to keeping quality. Wm. B. Esselen, Jr., and C. R. Fellers. Plant Physiol. 12:527-536. 1937.

The carbon dioxide content and the carbon dioxide–oxygen ratio of cranberries vary directly with the keeping quality of the fruit, the rate of respiration, and the temperature. Carbon dioxide–oxygen ratios under 0.7 seem to show that the berries are fairly sound and possess good keeping quality. As the ratios increase above 1.0, the quality of the cran-

berries becomes poorer and poorer. Freshly picked cranberries show a carbon dioxide–oxygen ratio of from 0.3 to 0.6.

254 Composition and utilization of the Atlantic Whiting, Merluccius bilinearis. D. A. Bean, J. A. Clague and C. R. Fellers. Trans. Amer. Fish. Soc. 66 (1936):415-421. 1937.

Whiting flesh contains approximately 16.6 percent protein, 2 percent fat, and 1.1 percent ash. The liver oil is an excellent source of vitamins A and D, containing 2700 international units of A and 950 units of D per gram. Smoked fillets, either fresh or canned, were considered the most promising whiting product.

257 Nutritive value of chocolate flavored milk. W. S. Mueller and W. S. Ritchie. Jour. Dairy Sci. 20 (6):359-369. 1937.

The effect of the addition of varying percentages of cocoa to mineralized whole milk was studied by means of growth experiments on a total of 72 albino rats. Milk containing 1 percent of cocoa gave results equal in all respects to those obtained with the plain whole milk. When milk containing more than 1 percent of cocoa was fed ad libitum, the rate of consumption decreased as the percentage of cocoa increased; when fed in controlled amounts, the growth of the rats was retarded. Assuming that these results may have some application to human nutrition, it seems reasonable to conclude that the cocoa in average commercial chocolate milk does no harm nor does it enhance the nutritional value of the milk.

259 The relation of ingested carbohydrate to the type and amount of blood and urine sugar and to the incidence of cataract in rats. Helen S. Mitchell, Oreana A. Merriam and Gladys M. Cook. Jour. Nutrition 13 (5):501-511. 1937.

The discovery and repeated confirmation of the fact that lactose and galactose rations may cause cataract in rats has been followed in this laboratory by extensive investigations as to the nature of the metabolic disturbances involved. The present studies into the nature of the blood and urine sugar of rats fed high levels of these two sugars have been made in connection with further observations on factors influencing the rate of development of lens opacities. It may be concluded that galactose is the sugar responsible for both the high blood and the high urine sugars observed in rats fed on lactose and galactose rations and must be the major etiological factor in this type of cataract.

261 A chlorosis of cultivated blueberries. J. S. Bailey. Amer. Soc. Hort. Sci. Proc. 34:395-396. 1937.

Two years ago there appeared in certain portions of plantations of cultivated blueberries at Amherst a chlorotic condition of the plants which seemed to be due to a nutritional deficiency. Affected plants were also found in Hanover and on Cape Cod as well as in New Jersey. Various treatments were tried, but the only one which has so far seemed effective was an application of ammonium sulfate, and recovery took about a year.

263 A genetic study of Tropaeolum. W. G. Whaley and A. P. French. Amer. Soc. Hort. Sci. Proc. 34:598-602. 1937.

The data included in this report have been compiled after observing the results of an interspecific cross between *Tropaeolum majus* var. Golden Gleam (female) and *T. peltophorum fimbriatum* (male) in the F_1 and F_2 generations.

264 Influence of certain fruits on fecal flora and intestinal reaction in diets of rats. William B. Esselen, Jr. Food Research 2 (1):65-72. 1937.

In order to study further the apparent beneficial action of fruit diets for intestinal disorders, work has been carried on to note the effect of cranberry, blueberry, and apple diets on the intestinal flora, putrefaction, and acidity of the albino rat. A 20 percent cranberry diet was effective in reducing the numbers of fecal gas-producing bacteria and *Escherichia coli*. Diets containing 20 percent cranberry, blueberry, and apple materially decreased intestinal putrefaction. Diets of 10 and 20 percent raw cranberry, and of 100 percent raw apple significantly increased the acidity of the contents of the cecum and large intestine.

265 Vitamins A, C, and D in maize as affected by variety and stage of growth. W. B. Esselen, Jr., C. R. Fellers and B. Isgur. Jour. Nutrition 14 (5): 503-511. 1937.

Vitamin A increased with growth of the plant above 25 cm., while vitamin C decreased. There was no correlation between the amounts of vitamins A and C in the plant and the

color of the grain. There was a marked loss in vitamin A and moisture after the plants had attained maximum growth. This loss of vitamin A in mature corn fodder is a factor to be considered in the use of fodder as an animal feed. The grain of yellow maize lost much of its vitamin A as it matured and dried out.

266 Some observations on internal cork disease of apples in Massachusetts. J. S. Bailey and W. H. Thies. Amer. Soc. Hort. Sci. Proc. 34:187-191. 1937.

During the season of 1936, an internal browning of the fruit of certain McIntosh and Cortland trees attracted considerable attention in Massachusetts. Our observations show that this disease is not limited to any one soil type, it occurs where the subsoil is unfavorable for root penetration, and is partially prevented by a heavy mulch. Trees with a shallow root system, from whatever cause, are at a distinct disadvantage in a time of drought. They may be unable to obtain an adequate supply of moisture during a part of the growing season, and it seems reasonable that this would prevent a normal development of the fruit. This association of the disease with water deficiency has been reported by several workers.

267 Tomato variety and strain differences in ascorbic acid (vitamin C) content. W. A. Maclinn, C. R. Fellers and R. E. Buck. Amer. Soc. Hort. Sci. Proc. 34:543-552. 1937.

Ninety-eight distinct varieties or strains of tomato grown under constant field conditions were found to vary in vitamin C content from a maximum of 249 to a minimum of 74 units per ounce. Different strains of the same variety showed marked differences in vitamin C. No correlation was found between size of tomatoes or degree of ripeness and vitamin C content. Data on storage tests indicate that the vitamin C of tomatoes is not seriously affected during shipment, in markets, or at canneries so long as the fruits remain firm and sound.

268 The Fungi of Nantucket. Century I. E. F. Cuba. Rhodora 39:367-376. 1937.

Dotted with ponds and bogs and sometimes enshrouded by heavy fogs and storms, Nantucket provides conditions which are especially favorable for a rich fungus flora and for epidemics of plant diseases. It is the hope of the author to make a fairly complete collection of the fungi of these islands and to publish the material in sets of centuries. This paper is the first of the series.

269 A photo-electric Tyndall meter. W. S. Mueller. Food Research 2 (1): 51-54. 1937.

The instrument here described was developed for the purpose of studying the effect of temperature treatments on the light-scattering ability of gelatin sols and gels, where a a need was felt for an instrument extremely sensitive to light intensity.

270 Stability of vitamin C in sweet corn to shipping, freezing, and canning. C. F. Dunker, C. R. Fellers, and G. A. Fitzgerald. Food Research 2 (1): 41-50. 1937.

Raw, fresh-cooked, frozen, and whole-grain canned sweet corn are all moderately good sources of vitamin C (40 to 60 international units per ounce). Cream-style canned corn is a little lower than whole-kernel. Little loss in vitamin C occurs after picking and storage in the husk for a few days. Similarly, frozen corn can be defrosted and canned corn kept in the refrigerator for several hours after opening without appreciable loss of vitamin C.

271 Hatchability as related to seasons and hour of laying. F. A. Hays. Poultry Sci. 16 (2):85-89. 1937.

Under the conditions of incubation used, late hatching increased hatchability for hens but not for pullets. Hour of laying appeared to have no significant effect on fertility, embryonic mortality, or hatchability of fertile eggs.

273 Some milk superstitions. J. H. Frandsen. Jour. Home Econ. 29 (4):242-243. 1937.

The author unmasks some of the old superstitions regarding milk, in the hope that a knowledge of the facts will lead to an increase in the use of one of our best foods.

274 Careful culture recommended to avoid canker on gardenias. Harold E. White. Florists' Review, February 25, 1937.

This paper describes symptoms, the part of the plant affected, possible means of infection, and cultural methods which should keep the disease from becoming established.

275 The precipitation of erythrosin by members of the Coli-Aerogenes group. Ralph L. France and James E. Fuller. Zentbl. Bakt. II Abt., Bd. 97: 312-314. 1937.

It was thought that this reaction to erythrosin might be of value in differentiating members of the coli-aerogenes group; but the present studies did not confirm this.

277 Dextrose in the manufacture of fruit and vegetable products. Carl R. Fellers, Joseph Miller and Thomas Onsdorff. Indus. and Engin. Chem. 29:946-949. 1937.

As a rule crystalline dextrose can be used in most canned fruits and fruit products to the extent of from 20 to 40 percent of the total sugar added. In some cases an improved product resulted. Dextrose is particularly suitable for use in sweet pickles and relishes, candies, and soda fountain syrups.

278 A polyuronide from tobacco stalks. Emmett Bennett. Indus. and Engin. Chem. 29:933. 1937.

The isolation and partial analysis of a polyuronide from the cured stripped stalk of Havana seed tobacco is described. Upon hydrolysis the polyuronide yields xylose as the chief sugar.

279 Influence of protein or cystine intake on cataract-producing action of galactose. Helen S. Mitchell and Gladys M. Cook. Soc. Expt. Biol. and Med. Proc. 36:806-808. 1937.

Ever since it was first demonstrated that galactose causes lens changes in rats, experiments have been under way in an effort to explain the metabolic disturbances involved. The data presented show that a protein deficiency definitely hastens the development of galactose cataract, but leave it doubtful whether cystine is the crucial factor.

280 A study of oiling off of cream in coffee. Herbert Jenkins and Merrill J. Mack. Jour. Dairy Sci. 20 (11):723-735. 1937.

The fat emulsion in cream is frequently destabilized to the extent that some of the fat will rise to the surface when the cream is used in coffee, a condition known as "oiling off." A suitable test for measuring the extent to which cream will oil off in coffee has been developed and is described in this paper. Factors which affect the stability of the fat emulsion in cream and therefore have a bearing on the problem of oiling off are discussed.

282 A preliminary study of the relationship between vitamin C content and increased growth resulting from fertilizer applications. B. Isgur and C. R. Fellers. Jour. Amer. Soc. Agron. 29 (11):890-893. 1937.

Preliminary data obtained from pot experiments using New Zealand spinach and Swiss chard show that increases in yield caused by fertilizer application were accompanied by increases in vitamin C content in the case of Swiss chard but not in the case of New Zealand spinach. The high nitrogen treatments resulted in the highest yields of ascorbic acid in the Swiss chard.

284 Oat flour as an antioxidant in ice cream. W. S. Mueller and M. J. Mack. Ice Cream Trade Jour., October, 1937.

Oat flour was found to have antioxidative properties when used in ice cream, the use of only 0.25 percent of oat flour in the mix delaying the development of off-flavors in the ice cream during storage, although 0.5 percent was more effective. Oat flour also has the properties of a stabilizer, and when it is added to the mix a reduction should be made in the amount of other stabilizer used.

288 Browning of Conifers. Malcolm A. McKenzie. American Nurseryman 66 (11):10. 1937.

Brown needles on conifers in autumn result from a variety of causes and may not be of a type that means permanent injury to the trees. An examination of the buds will furnish the best clue as to whether the browning is a natural condition of a healthy tree or is due to some injury. Plentiful firm green buds indicate a healthy tree, while a scarcity of buds or buds with colorless tissue indicate weakened or injured trees.

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